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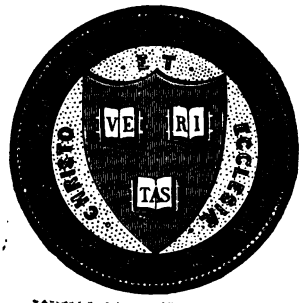


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# RESISTANCE OF THE AIR

TO THE

# MOTION OF PROJECTILES.

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# A REVISED ACCOUNT

OF

THE EXPERIMENTS MADE WITH

# THE BASHFORTH CHRONOGRAPH,

TO FIND

# THE RESISTANCE OF THE AIR

TO THE

# MOTION OF PROJECTILES,

WITH THE

APPLICATION OF THE RESULTS TO THE

# CALCULATION OF TRAJECTORIES

ACCORDING TO

# J. BERNOULLI'S METHOD.

BY

FRANCIS BASHFORTH, B.D.

LATE PROFESSOR OF APPLIED MATHEMATICS TO THE ADVANCED CLASS OF R.A. OFFICERS, WOOLWICH; AND FORMERLY FELLOW OF ST JOHN'S COLLEGE, CAMBRIDGE.

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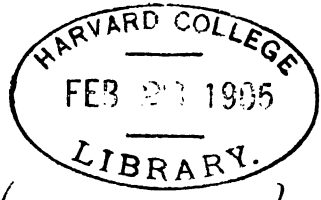


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# PREFACE.

WHEN my previous work on the Motion of Projectiles was published in 1873 the correct law of resistance of the air had been determined only for velocities between 900 and 1700 feet per second. The extensive experiments made at Shoeburyness in 1878, 1879 and 1880 with ogival-headed projectiles completed the law of resistance for velocities between 100 and 2800 feet per second, but it was not found possible to assign any simple expression for the law of resistance in terms of the velocity. The Newtonian and cubic laws may however be used, excepting perhaps a brief interval just below the velocity of sound.

The generous recognition of the practical value of my labours by the Marquis of Hartington, when Secretary of State for War in 1885, induced me to attempt to complete my labours by the calculation of tables of integrals for a resistance varying as the *square* of the velocity. So far as seemed necessary similar tables for the *cubic* law of resistance have been reprinted from my former work on the same subject.

The results of my experiments have been extensively used in government treatises on Ballistics since 1877 (114). Also Captain Ingalls has given an extended and careful explanation of my results and method of experimenting in his Text-Book on *Exterior Ballistics* prepared for the use of officers under instruction at the United States Artillery School, 1886. And

Major Wuich, Professor der Artillerielehre am k. k. höheren Artilleriekurse, Wien, has abridged my tables and presented them in a new form in his *Aeussere Ballistik*, 1886.

In order to furnish the reader with full information respecting the foundation on which my work rests, I have carefully revised all my original observations and given full particulars of the results finally adopted. This re-examination of every round has introduced trifling changes in the coefficients of resistance for both spherical and ogival-headed projectiles. I have therefore taken the trouble to recalculate my General Tables for both forms of projectile, in order to render my work consistent throughout. The whole has been adapted to the use of French as well as English measures.

The close agreement between calculated and experimental ranges and times of flight for high muzzle velocities and low elevations shows that my coefficients are well adapted for the best guns of the present day. But when projectiles are fired with high muzzle velocities at high elevations, the calculated ranges and times of flight are both generally less than those given in the range tables. This discrepancy, I have no doubt, is caused in a great measure by the vertical drift of the elongated projectile, which causes an increase of range and time of flight. In fact the explanation of lateral drift given by Magnus and others also accounts for a vertical drift which is really the origin of all drift.

Recently some rounds have been fired from a wire gun at high elevations with a very high muzzle velocity, commonly spoken of as the Jubilee Rounds. But it unfortunately happened that the wind was more or less favourable to a long range in these experiments. And a moderate steady wind at the surface of the earth would become a very violent wind at a height of two or three miles, which would produce a marked effect on the motion of an elongated projectile exposed to its action for 50 or 60 seconds. I have calculated a complete range table for the case where there is no wind to disturb the motion of the projectile.

The statements and proceedings of some foreign writers on ballistics have rendered it incumbent on me to enter at some length into the history and progress of my work during the last twenty-six years. But I have confined these remarks chiefly to the conclusion of my work, so that the reader need not trouble himself unless he feels an interest in the matter.

In calculating trajectories it has of late become a common practice to reduce my coefficients, either arbitrarily, or so as to bring them into accord with those of Krupp. But I have not been able to find any satisfactory experimental authority for Krupp's tables issued in 1881. Certainly in the following year an "Annexe" (177), consisting of 37 rounds, was put forward to support a foregone conclusion, but these experiments from their nature were not to be depended upon (177), and in no single case was the time of flight recorded. The specimen of the experiments made to determine the resistance of the air for velocities higher than 700 m.s. (181) ought to establish the character of Meppen for ballistic experiments. In all cases the Krupp party were careful to follow and not to lead. An inspection of diagram (178) will show how carefully they followed my law of resistance, merely reducing my coefficients, as is shown by line 3 compared with line 1 or 2.

In 1872 Mayevski combined my results published in 1868 with a few of his own experiments, from which he professed to have obtained "résultats *russes* et anglais," which however coincided with my previously published results (169). Consequently, so far as Mayevski's experiments had any value, they entirely supported my previous conclusions.

The method of calculating trajectories published by Siacci requires all the three tables previously used by Niven for that purpose. Ingalls (173) has pointed out a grave defect in that Siacci has not found an analytical expression for a most important quantity, $\alpha$ or sec $\overline{\phi}$, but has merely given the empirical rule $\sec \overline{\phi} = (\sec \phi)^{\frac{n-2}{n-1}}$. Turning to Niven's paper it will be found that the two values of this quantity required for distance and for time have been carefully determined, and still more so in a paper

*On certain Approximate Formulae for calculating the Trajectories of Shot,* by Professor Adams (*Nature*, Jan. 16, 1890). It must be plain that arbitrary coefficients of resistance, and empirical quantities are quite inadmissible in any calculations made to test the results of careful experiment. Krupp, Mayevski and Siacci use tables of the same kind as mine (108) and (110).

The reader will find in the following work a very full account of every round from which coefficients of resistance have been obtained by me for both spherical and ogival-headed projectiles. In consequence of the Krupp scare, special experiments were made in 1887 to test my coefficients on a long range, when they were found to be quite satisfactory. Still no notice seems to have been taken of this fact, or of Captain May's remarks (151), by calculators of trajectories.

My coefficients of resistance for low velocities have been tested (122) by calculating a Range Table for the 6·3-inch Howitzer for elevations 5° to 35° with satisfactory results.

For high velocities I have used the Range Table for the 4-inch B.L. gun. The calculated ranges and times of flight for velocities 1900 to 960 f.s., and for elevations 1° to 4° (125), are quite satisfactory; and this conclusion is confirmed by the use of the General Tables (126) and (188). In the same manner the Range Table of Captain May, R.N., has been used (123), (124) and (189) to show the accuracy of my coefficients of resistance *when the projectile moves nearly in the direction of its axis.*

I therefore claim to have accomplished in a satisfactory manner all I undertook to do, namely, to find by experiment the law of resistance to spherical projectiles and also to elongated projectiles when they move approximately in the direction of their axes.

---

The tables and coefficients already given are sufficient for the calculation of trajectories of spherical projectiles and of elongated projectiles where there is no sensible drift. But

in attempting to calculate the trajectories of elongated projectiles fired from rifled guns with high muzzle velocities and at considerable elevations, it will be well to recognise the truth of the statement of St-Robert—that the problem taken in all its generality presents great difficulties. I have endeavoured to explain the nature of the movement of such an elongated projectile, which is supposed to be projected with perfect steadiness from a rifled gun, according to the conclusions of St-Robert. Referring to (141) it is evident that shortly after the elongated projectile leaves the gun *it must be raised up bodily* by the resistance of the air, so as to cause it to move as if it had been fired at a somewhat higher elevation than it really was. I have given the calculated ranges and times of flight for elevations of 1° to 15° for the 4-inch B.L. gun (148). As the elevation increases above 4° it appears that the calculated ranges and times of flight fall short more and more of those quantities respectively given by experiment. Suppose we reduced the coefficients of resistance so as to obtain a calculated range equal to the experimental range for an elevation of 10°, we should find, as Captain May did (151), that these coefficients would not give a correct time of flight—and they would destroy the agreement actually obtained for low elevations. The reduction of the coefficients of resistance therefore cannot be the solution of the difficulty, as is commonly supposed. Some correction is required which will increase *both* the calculated range and time of flight.

In (149) the calculated ranges of (148) are arranged in a different manner. I have found from the Range Table the elevation and time of flight corresponding to each calculated range. It is evident that the corrections for elevation at once give the correct ranges and very approximate corrections for the times of flight. These latter corrections would have been still more satisfactory if the decrease in density of the air corresponding to the height of the shot had been taken into account in the calculation of the trajectories (148). For the reason stated (146) this mode of correction will be only an approxima-

tion to the truth—but it will perhaps be found to be satisfactory. The law of the correction can only be obtained by the calculation of numerous trustworthy Range Tables, or by theoretical considerations.

I fear that the reader will meet with some repetitions in the following work, but it was impossible to avoid them entirely on account of the complicated nature of the various questions to be dealt with. Although it will not surprise me to find that what has been said produces little immediate effect, it will always be a satisfaction to me to have stated my case carefully and supported it by reference to, and specimens of, my early results and tables, in none of which have I found it necessary to introduce any important change.

The English Range Tables I have made use of appear to me surprising from their minute accuracy. I have derived much assistance from Captain Ingalls's excellent work on Exterior Ballistics, and the numerous references to that work will explain in what respect I am indebted to his labours.

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*March*, 1890.

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# CHAPTER I.

## INTRODUCTION.

1. THE leading mathematicians of the last two centuries gave much attention to the subject of Ballistics. They seem to have accomplished all that was possible in such a case, in the absence of reliable experiments by which they could test their theories. Galileo made the first attempt to determine the theoretical path of a projectile acted on by gravity, but unresisted by the air, in his *Scienze Nuove*, 1638, and found it to be a parabola. Newton investigated the theoretical path of a projectile, supposing the air to offer a resistance varying as the velocity. In 1718 Keill proposed his famous challenge to Continental mathematicians, "Invenire curvam, quam projectile de-"scribit in aëre, pro simplicissima suppositione gravitatis, atque "medii densitatis uniformis, resistentiæ vero in duplicata ratione "velocitatis[1]." J. Bernoulli soon solved the problem, supposing the resistance to vary as *any power* of the velocity, but before publishing his solution, he called upon Keill to produce his own, telling him that if he did not do as he was requested, he should accept his silence "pro tacita confessione suæ imbecilitatis." As the required solution was not produced Bernoulli triumphed not over Keill only, but also over all his English friends, who might have been expected to help him if they had known how to do so. Bernoulli refers[2] to a solution received from Brook Taylor on the 6th of November, "styli veteris," under the form $(r^4 - 1 + 4nrr + 4ur^2)$. Hermann had also given a construction in his *Phoronomia*, p. 354, similar to his own.

[1] J. Bernoulli, Opera, II. 396. [2] Ib. p. 399.

2. Le Seur and Jacquier remark in their edition of Newton's *Principia* (Book II., Prop. X., Prob. III.), that although Newton had omitted to consider the case of a medium resisting as the *square* of the velocity, they were unwilling that the solution of such an elegant problem should be absent from their commentaries. Having given Bernoulli's solution for any power of the velocity, they remark "ex quibus manifestum sit veræ trajectoriæ "descriptionem adeò perplexam esse, ut ex illa vix quidquam ad "usus philosophicos aut mechanicos accommodatum possit deduci." That is, it was impossible to integrate the expressions arrived at. But this solution is the one employed in this as well as in my former work. Euler also adopted Bernoulli's solution, and applied it to the case where the resistance varied as the square of the velocity. In this particular case the length of the arc of the trajectory can be found by integration. Euler divided the trajectory into small arcs, and, supposing the chord to be equal to the arc in length, by summation he found the coordinates of the path. This method of calculation was pursued by Grævenitz[1] (1764), Hugh Brown[2] (1777), and Otto[3]. But Legendre introduced a much-needed correction by treating the arc of the trajectory as the arc of a circle, and projecting its *chord* upon the axes of $x$ and $y$. Another method of correction proposed by Didion was to use the arc of a parabola instead of the arc of a circle[4]. Didion has given comparative examples of the use of these methods. Lambert, Tempelhof, Francois, Otto and others have made use of long series too complicated for practical use, although Otto has provided numerous auxiliary tables[5]. His other ballistic tables were only adapted for calculating the trajectories of shot fired at high elevations.

3. But there were no trustworthy means of comparing the results of theory and experiment until Robins, by the use of his ballistic pendulum and his whirling machine, made valuable attempts to discover the law of resistance of the air to the motion of small-arm bullets. He describes his ballistic pendulum as follows:—"$A\,B\,C\,D$ represents the body of the machine "composed of the three poles $B, C, D$, spreading at bottom, and

[1] Translated by Rieffel, 1845.
[2] Translation of Euler.
[3] Tafeln für den Bombenwurf. Translated by Rieffel, as Tables de Balistiques Générales pour le tir élevé, 1845.
[4] Balistique, pp. 215, 216.
[5] Neue Bal. Tafeln, 1857.

"joining together at the top $A$....On two of these poles towards "their tops are screwed on the sockets $R\,S$; and on these sockets

"the pendulum $E\,F\,G\,H\,I\,K$ is hung by means of its cross piece "$E\,F$, which becomes its axis of suspension and on which it must "be made to vibrate with great freedom. The body of this pen- "dulum is made of iron, having a broad part at bottom which "cannot be seen in this scheme....The lower part of the pendulum "is covered with a thick piece of wood $G\,K\,I\,H$, which is fastened "to the iron by screws. Something lower than the bottom of "the pendulum there is a brace $O\,P$, joining the two poles to

"which the pendulum is suspended; and to this brace there is "fasten'd a contrivance $MNU$, made with two edges of steel "bearing on each other in the line $UN$, something in the manner "of a drawing-pen....There is fasten'd to the bottom of the "pendulum a narrow ribbon $LN$[1]" which is used to measure the recoil of the pendulum. Robins published his *New Principles of Gunnery* in 1742, in which he adopted a law of resistance varying approximately as the square of the velocity, but he insisted that there was a decided change in this law at or about the velocity of sound. This position was doubted till it was confirmed by recent experiments. In reply to some adverse criticisms on his work, several papers were read and illustrative experiments were exhibited by Robins before the Royal Society. He remarked, "But as I have, for some time past, made many experiments "myself on the ranges of bullets, and have collected all that I "could meet with made by other persons; it was necessary, in "order to examine the several hypotheses of resistance, which "some of these experiments suggested, that I should be enabled "to compute the motions of resisted bodies, not only when they "were resisted in the duplicate proportion of their velocity; but "likewise when the law of resistance was varied by other rules "not hitherto supposed by any writer. And, in these investi- "gations, I had the good fortune to discover some compendious "approximations, which were as accurate, as the nature of the "subject required, and were as easy in their application, as I "could well hope for in so perplexed and intricate a matter....But "first it is necessary to examine what is the real law of resistance "of bodies moving through the air.

"I have already mentioned, that in very great changes of "velocity, the resistance *does not accurately follow the duplicate "proportion* of the velocity. But how much this variation "amounts to, and how it is adapted to the different velocities of "the resisted body; it is not easy nicely to ascertain. However, "by comparing together a great number of experiments; I am "of opinion, that till, a more accurate theory of these changes "is compleated, the two following positions may be assumed "without any remarkable error[2]."

[1] New Principles of Gunnery, p. 83.

[2] Robins's Gunnery, I. 180—183, and Hutton's ed., 180—183, 1805.

4. "*First*, that till the velocity of the projectile surpasses "that of 1100 feet in a second, the resistance may be esteemed "to be in the duplicate proportion of the velocity; and its mean "quantity may be taken to be nearly the same with that, I have "assigned in the former paper[1].

"*Second*, That if the velocity be greater than that of 11 or "1200 feet in a second, then the absolute quantity of that re- "sistance in these greater velocities will be near three times "as great, as it should be by a comparison with the smaller "velocities.—For instance, the resistance of a 12 pound shot, "moving with a velocity of 1700 feet in a second, instead of "144 lb. $\frac{1}{2}$, which I have assigned it in a former paper, will be "now three times that quantity, or 433 lb. $\frac{1}{2}$[2]." And in a note Robins remarks, that "the velocity, at which the moving body "shifts its resistance, is nearly the same, with which sound is "propagated through the air."

5. On presenting to Robins the Copley Medal in recognition of the value of his work, Mr Folkes, President of the Royal Society, observed that, "It is from these experiments, and from "those others which Mr *Robins* is still preparing to exhibit, that "we may expect to see compleated the whole, and the true theory "of projectiles. What *Galileo* and *Torricelli*, who first demon- "strated the motions of these bodies *in vacuo*, knew to be still "wanting in their theories, will hereby be supplied: and these "particulars will at last become known, which they wished that "future observers would make diligent and careful experiment "about[3]." Previously, "writers, even those of the first class" have been of opinion "that in large shot of metal, whose weight "many thousand times surpasses that of the air, and whose force "is very great, in proportion to the surface wherewith they press "thereon, this opposition is scarce discernable, and as such may, "in all computations, concerning the ranges of great and weighty "bombs be very safely neglected[4]."

The choice of "two very considerable employments" having been offered to Robins, as a reward for his labours, he accepted the office of Engineer-General to the East-India Company "as "it was suitable to his genius, and where, he believed, he should

[1] Note by Hutton, "These suppositions are not nearly correct," 181.

[2] New Principles, I. 182, Hutton's ed., pp. 180—182.

[3] New Principles, I. p. xxx. [4] Ib. p. xxxi.

"be able to do real service, *as not being liable to be hindered* "*through the suggestions of design or ignorance, which by their* "*boasting and importunity, often insinuating themselves into the* "*direction of publick affairs, frequently render abortive the best* "*concerted schemes*[1]." The Company settled upon him £500 a year during life, on condition that he continued in their service five years. He left England for India in 1749 and died at work 1751.

6. Euler at once published a translation of Robins's *New Principles*, and illustrated the work with a lengthy commentary (1745). He also contributed a paper on the same subject to the *Memoires de l'Acad. de Berlin*, 1753, in which he showed how theoretical trajectories might be calculated according to the solution of the problem by J. Bernoulli, but only for a resistance varying as the *square* of the velocity. Both Euler's paper and his commentaries on Robins's *New Principles* were translated and published in 1777 by Hugh Brown, who also carried out the calculation of seventeen species of trajectories according to Euler's example and instructions. The like had been done previously by Grævenitz in 1764, as already stated, but the calculations appear to have been made independently. The weight of the ballistic pendulum used by Robins was only 56 lbs. 3 oz.

7. At Woolwich, in the year 1775, in conjunction with some able officers of the Royal Regiment of Artillery and other ingenious gentlemen, was first instituted a course of experiments on fired gunpowder and cannon-balls, similar to the course carried on afterwards during the years 1783–5, 1787–9, 1791, &c. Hutton's account of the earlier experiments was printed in the *Philosophical Transactions* for 1778, and was honoured with the annual medal of the Royal Society. Hutton[2] remarks, "That part of Mr Robins's "book has always been much admired, which relates to the experi- "mental method of ascertaining the actual velocities of shot, and "in *imitation* of *which*, but on a *large scale*, those experiments "were made which were described in my paper. Experiments in "the manner of Mr Robins were generally repeated by his com- "mentators, and others, with universal satisfaction; the method "being so just in theory, so simple in practice, and altogether so "ingenious that it immediately gave the fullest conviction of its

[1] New Principles, p. xl.

[2] Tracts, Vol. II. p. 307.

"excellence, and the eminent abilities of the inventor. The use "which our author made of his invention, was to obtain the real "velocities of bullets experimentally, that he might compare them "with those which he had computed *a priori* from a new theory "of gunnery, which he had invented, in order to verify the prin- "ciples on which it was founded. The success was fully answerable "to his expectations, and left no doubt of the truth of his theory, "at least when applied to such pieces and bullets as he had used. "These however were but small, being only musket balls of about "an ounce weight."

8. Hutton endeavoured to supply the want of results of experiments with larger balls by using shot from 1 lb. to near 3 lbs., and finally 6 lbs. in weight. He employed the ballistic pendulum of Robins, as that was at that time the only practical method of ascertaining the velocities of military projectiles, except that practised by Count Rumford, who suspended the gun and measured its recoil. Hutton commenced his experiments with a pendulum weighing between 500 and 600 lbs. in 1783; it was increased to 1014 lbs. in 1788; in the following year to 1655 lbs. and at last to 2099 lbs. Full particulars of the rounds fired have been carefully given. For the determination of resistances at low velocities Hutton used Robins's whirling machine.

9. Hutton states that his experiments of 1787, 88, 89 and 91 "were chiefly instituted to obtain the effects of the air's resistance "to balls in their rapid flight through it. To determine the "resistance to the very high velocities, were employed balls of "three several sizes, viz. of 2 inches, 2·78 inches, and 3·55 inches "in diameter. These were discharged with various degrees of "velocity, from 300 feet to 2000 feet in a second of time; and they "were also made to strike the pendulum block at several different "distances from the guns, in order to obtain the quantity of velo- "city lost, in passing through those spaces of air; whence the "degrees of resistance were obtained, appropriate to the different "velocities. These series of resistances for the three sizes of "balls above-mentioned, have been obtained in a state remarkably "regular, not only each series in itself, but also in comparison "with each other; the terms in every one of them following a "certain uniform law, in respect of the velocity, being indeed "nearly as the $2\frac{1}{10}$ power of the velocity; and the terms of any "one series also, as compared with the corresponding terms of

"another, with the same velocity, these being in a constant pro-
"portion to one another," viz. as the surfaces of the balls moved
"nearly, or as the squares of their diameters, with about $\frac{1}{20}$ part
"more in counting from the less ball to the greater, or $\frac{1}{20}$ part less
"when comparing the greater ball to the less[1]." Finally, Hutton expresses the resistance of the air in pounds to a spherical shot $d$ inches in diameter, moving with a velocity $vf.s.$[2], by

$$(\cdot 000007565v^2 - \cdot 00175v)\, d^2.$$

10. The proposal to introduce some changes into the English Artillery in 1815 determined the director of the Royal Academy and Dr Gregory, professor in the same establishment, to cause a ballistic pendulum to be constructed *three times greater* than that of Hutton, with which to experiment with shot of 24 lbs. The weight of the pendulum was 7408 lbs. Shot of 6, 9, 12 and 24 lbs. were fired into the wooden block of this ballistic pendulum, *from guns of different lengths* with various charges[3]. Other experiments[4] were made in 1817, 18, at Woolwich to determine the influence of windage on the initial velocities of shot. The results obtained do not appear to have any permanent value.

11. General Piobert[5] recalculated the experiments of Hutton and obtained a formula of resistance

$$\rho = \pi R^2 \times 0{\cdot}030586\,(1 + 0{\cdot}0023\,V)\,V^2.$$

12. General Didion has remarked that the experiments made by Hutton in England on small projectiles "incomplétement "formulées par ce savant observateur" had for a long time formed the sole base of ballistic applications. Piobert had succeeded in representing Hutton's results by a formula of two terms. The experiments made at Metz in 1839 and 1840, on projectiles of service calibres, had enabled him to obtain coefficients of resistance applicable to *guns in actual use*. The coefficients deduced from the experiments of Hutton and from those obtained at Metz did not agree. But recalculating Hutton's experiments by a perfectly suitable method, and introducing the same corrections, he found there was no sensible difference between them. Shot of 8, 12, and 24, weighing respectively 8·86 lbs., 13·38 lbs, and 26·47 lbs., and also a shell of 8·66 inches, weighing 50·71 lbs. were used

[1] Tracts, III. pp. 216. 217.
[2] Ib. p. 232.
[3] Ann. de Ch. et de Ph., v. p. 380.
[4] Ib. IX.
[5] Mem. de l'Acad., 1836; and Didion, Lois, p. 22.

at Metz. The ballistic pendulum when filled with sand weighed about 6000 kilogrammes, or 13,228 lbs. All particulars of the experiments will be found in "*Lois de la Résistance de l'Air sur les Projectiles.*" Par Is. Didion, Paris, 1857. The consideration of all the experiments made with the ballistic pendulum led to the adoption of the formula $\rho = 0{\cdot}027\pi R^2 V^2 (1 + 0{\cdot}0023 V)$[1] in French measures, or to $r = 0{\cdot}0000028 d^2 v^2 (1 + 0{\cdot}0007 v)$ in English measures. Didion observes that the pendulum of Robins, formed of a simple plank of wood, suspended by a single bar, was the most susceptible of all to torsion and disturbances, and gave the highest result; that the pendulum of Hutton better constructed and suspended by *two* bars, gave results higher with the 3 lb. and 6 lb. balls than with the 1 lb. ball; and that these were higher than those of the experiments made at Metz with a very massive pendulum suspended by *four* bars, and very rigid.

From these considerations Didion concludes that the divergences observed proceeded from the imperfection of the apparatus, and that the lower results obtained with the apparatus

| Velocity | Hutton 1791 | | Didion 1840 | | Bashforth 1868 |
|---|---|---|---|---|---|
| *f. s.* | lbs. | Correction required | lbs. | Correction required | lbs. |
| 100 | 0·2 | | 0·1 | | |
| 200 | 0·7 | | 0·5 | | |
| 300 | 1·6 | | 1·2 | | |
| 400 | 2·9 | | 2·3 | | |
| 500 | 4·7 | | 3·8 | | |
| 600 | 6·9 | | 5·7 | | |
| 700 | 9·8 | | 8·2 | | |
| 800 | 13·3 | lbs. | 11·2 | lbs. | |
| 900 | 17·5 | −4·7 | 14·8 | −2·0 | 12·8 |
| 1000 | 22·6 | −5·0 | 19·0 | −1·4 | 17·6 |
| 1100 | 28·6 | −3·1 | 24·0 | +1·5 | 25·5 |
| 1200 | 35·3 | −1·9 | 29·7 | +3·7 | 33·4 |
| 1300 | 42·7 | −2·1 | 36·2 | +4·4 | 40·6 |
| 1400 | 50·7 | −2·2 | 43·5 | +5·0 | 48·5 |
| 1500 | 59·2 | −2·5 | 51·7 | +5·0 | 56·7 |
| 1600 | 67·9 | −2·6 | 60·8 | +4·5 | 65·3 |
| 1700 | 76·8 | −2·7 | 70·9 | +3·2 | 74·1 |
| 1800 | 85·5 | −2·6 | 82·0 | +0·9 | 82·9 |
| 1900 | 94·1 | −1·3 | 94·2 | −1·4 | 92·8 |
| 2000 | 102·4 | +1·9 | 107·5 | −3·2 | 104·3 |

[1] Lois, &c., p. 78.

the most recent and most improved, and which are moreover the most numerous and obtained with *service* projectiles, ought to be regarded as the most exact.

13. The foregoing Table shows the resistance of the air to the motion of a spherical ball 2 inches in diameter, (1) as given by Hutton; (2) as calculated by Didion's formula; and (3) as calculated by the help of my own coefficients, 1868.

From the above table it appears that Didion was quite right when he declared that Hutton's results were too high. But he over-corrected them, and gave a formula which produced results that were too low. In fact for velocities 1200 to 1700 feet per second, Hutton's results were nearer the truth than Didion's.

14. Hutton expressly denied that there was any "shifting of "the resistance of the air" at or about the velocity of sound, such as Robins had pointed out[1]; while Didion gave a formula for the resistance of the air of the form

$$AV^2(1+BV) = AV^3\left(\frac{1}{V}+B\right),$$

so that the coefficient of $V^2$ increases as $V$ decreases; but my experiments show that there is a sudden decrease in the value of this coefficient in the neighbourhood of the velocity of sound.

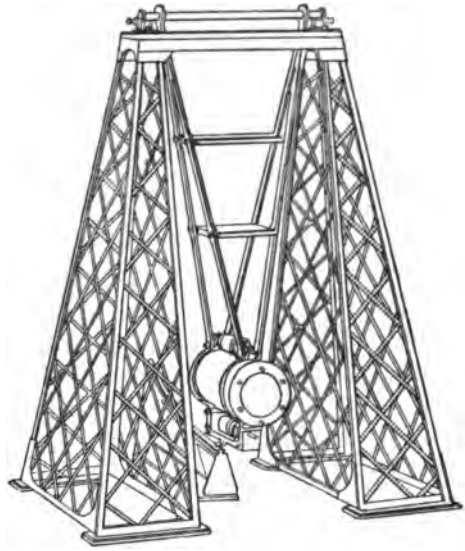
It gives me great pleasure to exhibit the valuable work done by these early experimenters, who worked together in the best possible spirit—each ready to recognise the value of his predecessor's work. Hutton brought out a new edition of Robins's *New Principles*, &c., while Didion recalculated Hutton's experiments.

15. Finally a monster ballistic pendulum was constructed for the English Government in 1855 by Messrs Armstrong and Co. It was first set up at Shoeburyness, afterwards removed to Woolwich, and finally dismantled without ever having been used in any course of experiments. It therefore gave no results. But still an elaborate model of this useless instrument was made for the Great Exhibition of 1862, which was reported to have cost £800. I do not know what was the weight of the pendulum-block in this case. The figure represents this ballistic pendulum, which was about twenty feet in height.

16. It was perhaps natural that each succeeding experimenter should be anxious to use shot of increased weight which involved

[1] Hutton's edition of Robins, p. 181.

the employment of heavier pendulum blocks. But on reviewing the work that has been done, it appears probable that the ex-



perimenters who followed Robins would have succeeded better if they had expended all their care and ingenuity upon experiments on a *small* scale. For Robins noticed a change in the law of resistance which was disputed or passed over in silence by succeeding experimenters with the ballistic pendulum. Now it is impossible to experiment satisfactorily with small-arm bullets by the help of *galvanic* chronographs, because they would generally pass between the strings of the screens without cutting them, or they would be rendered *unsteady* if they touched the threads of the screen. But with the great precision of the small arms now made there would be no difficulty in carrying out experiments with a *light* ballistic pendulum. I find that care was taken by the old experimenters to screen the block of the ballistic pendulum from the blast of the gun, but I have not noticed that any attempt was made to prevent the blast of air, which accompanies a shot, from acting upon the pendulum. It would be well therefore to place a thin paper screen just in front of the block of the pendulum, the bull's eye being marked on the paper in front of the point to be hit.

17. When I commenced experimenting in 1864 with a view to determine the resistance of the air to the motion of projectiles, the best results previously obtained were those derived from the use of the ballistic pendulum. The electro-ballistic instruments of Vignotti, Navez, Leurs, and others of the same type, were liable to frequent errors, and so were not adapted for use in determining the resistance of the air to projectiles. The want of an instrument capable of measuring the times occupied by a shot in passing over *a succession of equal spaces* was felt long ago, for in 1843 Col. Konstantinoff employed M. Bréguet, of Paris, to construct for him a chronograph. "Le problème était celui-ci: Disposer "un instrument qui pût indiquer et conserver trente ou quarante "observations successives, faites dans des espaces de temps tres "rapprochés, d'un phénomène se passant plus ou moins loin de "l'endroit où se trouve placé l'instrument d'observation[1]." The construction of the instrument was commenced in June, 1843, and completed on the 29th of May, 1844[2]. This instrument is described and figured by Du Moncel[3]. Hence arose a warm discussion between Wheatstone and Bréguet[4] of which Moigno[5] has given a long account. It is difficult to say what the dispute was all about, as it does not appear that results of any value were ever obtained by either party, for in 1856 Morin remarked that the problem had not even then been resolved in a way completely satisfactory. Du Moncel remarks, "Ce chronographe "fut, en 1845, l'object d'une discussion assez animée entre MM. "Wheatstone et Bréguet, de laquelle il est résulté que la *première* "*idée* des chronoscopes et chronographes électriques appartenait "bien à M. Wheatstone, mais que c'était au capitaine Konstanti- "noff que revenait *l'idée* d'enrigistrer la vitesse des projectiles aux "différents points de leur trajectoire, et à M. Bréguet que devait "être attribuée la disposition de l'instrument pour résoudre le "problème posé par M. Konstantinoff[6]."

18. Another chronograph, the invention of Captain Schultz, was exhibited at Paris in 1867, which was intended to register several records for each round. We were informed that "Captain "Schultz, in fact, finds that he can observe and register time to

[1] Moigno, Télégraphie, 1849, p. 95.
[2] Ib. p. 96.
[3] Applications, II. p. 337, 1856.
[4] Comptes-Rendus, 1845.
[5] Télégraphie, pp. 88—113.
[6] Applications, II. p. 337.

"$\frac{1}{10000000}$ of a second[1]!" Either the Ordnance Select Committee or the Committee on Explosives were not slow in securing such a promising instrument. But when they had got it they could not make it work, for although I inquired frequently, I could not learn that they had obtained any results fit to produce. The most elementary knowledge of the subject ought to have warned them that there were *three* objections to the satisfactory working of this chronoscope, any one of which would prove fatal:—(1) the badly contrived system of screens, (2) the use of the tuning-fork to divide the second of time, and (3) the use of the spark as the recording agent. The Schultz chronoscope was early used in the United States, but from Lt.-Col. Benet's[2] account, it appears to have only been applied to measure *initial* velocities. In this respect he speaks favourably of the instrument. But Captain Ingalls[3] has explained how the case stands now. He remarks, "the only "chronograph which can successfully compete with Bashforth's as "a means for studying the resistance of the air was invented by "Captain Schultz of the French Artillery, in 1864, the year in "which Professor Bashforth constructed his first instrument. "*Since that time it has been much improved by* M. Marcel-Deprez, "Lt.-Colonel Sébert of the French Marine Artillery, and Lieu-"tenant A. H. Russell of the U. S. Ordnance; and all the objec-"tionable features mentioned by the Bashforth committee have "been obviated. *As thus modified* it is strikingly like Professor "Bashforth's chronograph, and the same screens, batteries, arrange-"ments of circuits, and methods of reduction of observations can "be used in both." Still we have no results obtained by the use of this "modified" instrument, which was brought forward at Woolwich in its crude state in opposition to mine 20 years ago with little credit to its patrons.

[1] Practical Mechanic's Journal, Oct. 1867, p. 195.
[2] Electro-Ballistic Machines, 1866. [3] Ballistic Machines, 1885, p. 29.

## CHAPTER II.

### DESCRIPTION OF THE CHRONOGRAPH, WITH AN ACCOUNT OF EXPERIMENTS AND THEIR REDUCTION.

19. On the institution of the Advanced Class of Royal Artillery Officers at Woolwich in 1864 the Professorship of Applied Mathematics was offered to me by the Council of Military Education. I the more readily accepted that office because I saw my way to the satisfactory solution of the problem of the resistance of the air to the motion of projectiles. It was also a part of my duty to act as referee to the Ordnance Select Committee, at that time the scientific advisers of the Government. The Committee were possessors of the monster ballistic pendulum of 1855, which was useless, and electro-ballistic instruments of the type of Navez, which were unreliable, because they afforded no means of testing the accuracy of their results. I therefore submitted to the committee my plans for the construction of a chronograph adapted to record the times occupied by any shot in passing over a succession of equal spaces, for, if these records were found consistent with each other, or capable of being made so by allowable corrections, then the results must be trustworthy, supposing the law of resistance of the air not to be subject to any sudden change. This supposition has been found to be correct, except perhaps for velocities 1000—1100 f. s., where there is a rapid change in the law of resistance. But the Ordnance Select Committee did not require any new chronograph for their purposes, as they were at that time quite satisfied with the Navez chronoscope they possessed. It was perhaps fortunate that, for this reason, I was obliged to keep the construction of the new instrument in my own hands, for thus I was able to introduce improvements in any part which was found to be defective in the original design.

20. After a due consideration of all circumstances of the case, it appeared that the following conditions must be satisfied by a chronograph to be worthy of perfect confidence:—

(1) The time to be measured by a clock going uniformly.

(2) The instrument to be capable of measuring the times occupied by a cannon-ball in passing over at least *nine* successive *equal* spaces.

(3) The instrument to be capable of measuring the longest known time of flight of a shot or shell.

(4) Every beat of the clock to be recorded by the *interruption* of the same galvanic current, and under precisely *the same conditions.*

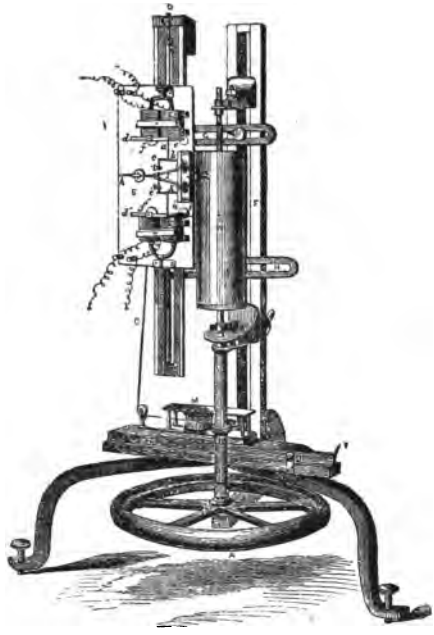
(5) The time of passing each screen to be recorded by the momentary *interruption* of a second galvanic current, and under precisely *the same conditions.*

(6) Provision to be made for keeping the strings or wires of the screens in *a uniform state of tension*, notwithstanding the force of the wind and the blast accompanying the ball.

21. The following is a description of the chronograph as constructed, and of various useful appendages. Fig. 3 gives a general view of the chronograph. *A* is a fly-wheel capable of revolving about a vertical axis, and carrying with it the cylinder *K*, which is covered with prepared paper for the reception of the clock and screen records. The length of the cylinder is 12 or 14 inches, and the diameter 4 inches. *B* is a toothed-wheel which gears with the wheelwork *M* so as to allow the string *CD* to be slowly unwrapped from its drum. The other end of *CD* being attached to the platform *S* allows it to descend slowly along the slide *L*, about $\frac{1}{4}$ inch for each revolution of the cylinder. *E*, *E'* are electro-magnets; *d*, *d'* are frames supporting the keepers; and *f*, *f'* are the ends of the springs which act against the attraction of the electro-magnets. When the current is interrupted in one circuit, as *E*, the magnetism of the electro-magnet is destroyed, the spring *f* pulls back the keeper, which turns about a hinge at *d*, and by means of the arm *a*, *gives a blow* to the lever *b*. Thus the marker *m* is made to depart suddenly from the uniform spiral it was describing. When the current is restored the keeper is attracted, and thus the marker *m* is brought back, which con-

tinues to trace its spiral as if nothing had happened. $E'$ is connected with the clock, and its marker $m'$ records the seconds.

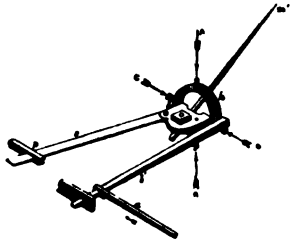
Fig. 3.



$E$ is connected with the screens, and records the passage of the shot through the screens. By measuring up the marks made by $m$, $m'$ the exact velocity of the shot can be calculated at all points of its course. The slide $L$ is fixed parallel to $F$ and the cylinder $K$ by the brackets $G$, $H$. $Y$ is a screw for drawing back the wheel-work $M$, and $J$ a stop to regulate the distance between $M$ and $B$. The depression of the lever $h$ raises the two springs $s$, which act as levers, and bring the diamond points $m$, $m'$ down upon the paper. When an experiment is to be made, care is taken to see that the two currents are complete. The fly-wheel $A$ is set in motion by hand, so as to make about three revolutions in two seconds. The markers $m$, $m'$ are brought down upon the paper, and after one or two beats of the clock the signal to fire is given, so that in about five seconds the experiment is completed, and the instrument is ready for another.

22. Fig. 4 gives a view of one of the markers, showing the way in which it is moved. The depression of the lever *h* (Fig. 3), raises *p*, and thus the lever *s*, which is formed of watch-spring wire, brings down *m'* to the paper, and keeps it gently in contact. This motion takes place within the circle *k*, about an axis *CD*. *a'* is an arm connected with the electro-magnet. When the magnetism in *E'* is destroyed, *a'* begins to move away, and when it has moved a short distance it *strikes* the lever *b'* a *sudden blow* which carries it as far as the hole in the stop *c'* will allow it to move. The lever *b'* is rigidly connected with the circle *k*, which is capable of moving about an axis *AB*. This motion is communicated to *m'*, which describes a very short arc of a circle about a point in *AB*. The arrangement is so made that when either of the markers *m*, *m'* is making a record, it has a motion which may be resolved partly in *direction of the motion* of the paper under it, and partly in a direction perpendicular to this. When these adjustments are properly made the records to be read off will be nearly at right angles to the spirals.

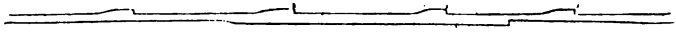
Fig. 4.



The pendulum of a half-seconds clock strikes once each double-beat a very light spring, and so interrupts the galvanic current in *E'* once a second.

The following diagram, Fig. 5, shows four screen records in the upper line, and one second record in the lower line, when the markers are properly adjusted.

Fig. 5.



23. Figs. 6 and 7 give the details of the screens. Fig. 6 represents a piece of board 1 inch thick and 6 or 7 inches wide,

and rather longer than the width of the screen to be formed. Transverse grooves are cut at equal distances, something less than the diameter of the shot, as shown in the diagram. Staples

Fig. 6.

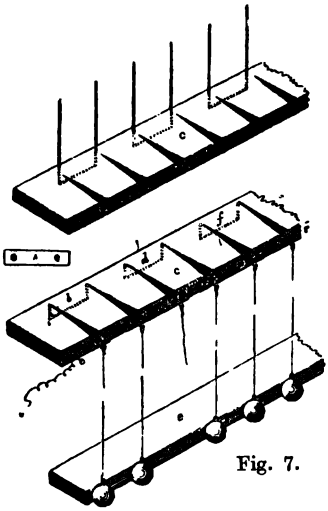


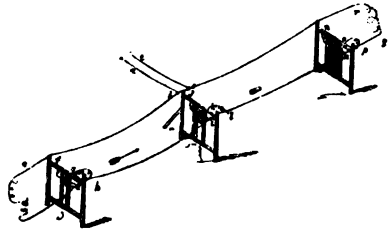
Fig. 7.

of hard brass spring-wire (No. 14 or 15), are fixed with their prongs in the continuation of the grooves. Pieces of sheet copper *A* are provided, having two elliptical holes, the distance of whose centres equals the distance of the grooves. The pieces of copper *A* are used to connect each wire staple, as *C*, with its neighbour on each side. Thus, Fig. 7 *a*, *c*, *e*, *g*, &c., represent these copper connections put in their places and holding down the wire springs, which, when free, are in contact with the tops of the holes; but, when properly weighted, they rest on the lower edge of the holes. Thus the copper *c* forms a connexion between the staples *b* and *d*; the copper *e* joins *d* and *f*, and so on. A galvanic current will therefore take the following course, whether the springs be weighted or unweighted: copper *a*, brass *b*, copper *c*, brass *d*, copper *e*, brass *f*, copper *g*, &c. The current will only be interrupted when one or more threads have been cut and the corresponding spring is flying from the bottom to the top of its hole. About $\frac{1}{50}$th of a second is required for the complete registration of such an interruption, the spring traversing about

half an inch. The shelf *B* is placed for the weights to rest against, partly to prevent them from being carried forward by the shot, but chiefly to prevent the untwisting of the threads which support the weights. The weights used were about 2 lbs. each, and the strength of the sewing cotton for supporting them was equal to a stress of about 3 lbs., which was sufficient to withstand a tolerably strong wind. As the weights were equal the threads were kept *equally* stretched.

24. The arrangement of the screens for an experiment is shown in Fig. 8. The wires for conveying the galvanic current

Fig. 8.

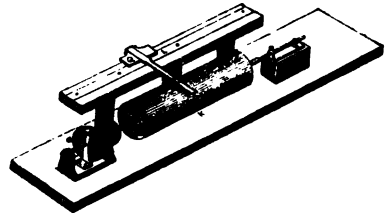


are, like the common telegraph wire, carried on posts. *abc* is a continuous piece of wire; but there are interruptions between *e* and *h*, between *i* and *l*, between *m* and *p*, &c., in order to make the galvanic current circulate through the screens. The course of the galvanic current is *a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t.* The ends *a, t,* are connected with the instrument and battery. The shot, being fired through the screens, in passing cuts one or more threads at each screen, so that corresponding to the instant at which the shot passes each screen there is an interruption of the galvanic current, and a simultaneous record on the paper cylinder.

25. When the cylinder is filled with spirals, that is after five or six rounds, it is transferred to the instrument, Fig. 9, where *a* is a circle divided into 300 equal parts, and the division is carried to 3000 by the help of a vernier. A small T-square, having a fine edge at *b*, moves along a brass straight-edge *L*, adjusted so as to be parallel to the axis of the cylinder. The mark *b* is carefully placed opposite each record on the paper by means of a tangent screw (not shown in the figure), and the

vernier is read. It would have been more convenient if the circle had been divided into 500 rather than 300 equal parts.

Fig. 9.



The clock goes on breaking the galvanic circuit every swing of the pendulum, whether the marker $m'$ be in contact with the paper or not—consequently, whatever be the loss of time in the action of the marker, we may fairly suppose it to be constant. But if the current had been circulating through the screens for several minutes, or even seconds, without interruption before the shot was fired, the records at the first and the following screens would not have been made under the *same* conditions.

26. To guard against any error from this source, an ordinary self-acting spring contact breaker was introduced into the screen circuit. The raising of a spring lever interrupts the main current of galvanism through the screens. The insertion of a pin to keep up the lever, re-opens a passage for the screen galvanic current through the contact breaker; this may be made also to ring a bell in the instrument room, to give notice that all things are ready for the experiment. The fly-wheel is then put in motion, the signal to fire is given; the pulling of the lanyard withdraws the pin and so restores the main current, and then fires the gun.

27. The construction of the chronograph was commenced in August, 1864; it was ready for trial in June, 1865. It received its first *partial* trial before the Committee on Gun Cotton in July 1865, in conjunction with Major Navez's Electro Ballistic Pendulum. The instruments gave a nearly constant difference of 20 f.s. in velocities of about 1500 f.s. The chronograph remained at the proof butts from July to November, 1865, when it was taken down to Plumstead Marshes and placed in a splinter-

proof, where it remained about a fortnight. Its powers to withstand damp and dust were well tested in this manner.

28. In carrying out a series of experiments it is advisable to provide convenient means for *interrupting* the *clock* galvanic current when the markers are raised. It is also desirable to have the means of *diverting* the *screen* galvanic current from its electromagnet to another adapted to ring a small bell in the instrument room, for then it is known what is going on on the range, if the circuit be not broken. These three operations of raising the markers, breaking the clock current and diverting the screen current might be effected by one motion, if the stage *e'd'de* (Fig. 3) between the fixed electro-magnets *E*, *E'* was made to rotate about its back edge *dd'*. Then, when preparing to fire a round it would only be necessary to press down the platform *d'e* to make everything ready for a new experiment.

29. As it is quite impossible to drive the cylinder which receives the records with a sufficiently *uniform* and known angular velocity, it was decided to place the axis in a vertical position in the manner shown in Fig. 3, and spin the instrument by hand. When the records of a successful experiment are read off, they show slight irregularities, which must be corrected so as to make the readings yield regular differences. The scale of time found in this way is a decreasing scale. By interpolation the places are found where the records for every *tenth* of a second would fall. On comparing the screen records, it is now possible to read off the time each screen was passed to the tenth of a second by the scale of time, and any remaining fraction of one-tenth of a second is found by proportional parts, on the supposition that the angular velocity of the cylinder is uniform for each tenth of a second. At first the time of passing each screen was expressed to *four* places of decimals of a second, which seemed quite sufficient for all practical purposes, but to secure satisfactory results it was found necessary to go to *five* places of decimals of a second. When this had been done, further extremely small corrections were required to make the calculated times of passing the screens difference properly. I will give round 148; hollow ogival headed shot, $d = 4{\cdot}92$ in.; $w = 23{\cdot}84$ lbs. as it was printed in the Report, Feb. 1869[1]; carried to four places of decimals, and also in the form in which it appears after the recent revision. The following

[1] Reports, &c. 1865—1870, p. 56.

statement gives the original readings and the corrections applied to them.

Clock

| | Readings | corn. | cord. readings | $\Delta^1$ | $\Delta^2$ |
|---|---|---|---|---|---|
| 2 | 19·27 | 0 = | 19·270 | + 24·280 | |
| 3 | 43·55 | 0 = | 43·550 | + 24·208 | − 72 |
| 4 | 67·78 | − ·022 = | 67·758 | + 24·136 | − 72 |
| 5 | 91·89 | + ·004 = | 91·894 | + 24·065 | − 71 |
| 6 | 115·95 | + ·009 = | 115·959 | + 23·995 | − 70 |
| 7 | 139·96 | − ·006 = | 139·954 | + 23·926 | − 69 |
| 8 | 163·88 | 0 = | 163·880 | | |

Screens

| | Readings | corn. | cord. readings | $\Delta^1$ | $\Delta^2$ |
|---|---|---|---|---|---|
| 1 | 78·61 | − ·002 = | 78·608 | + 2·627 | |
| 2 | 81·23 | + ·005 = | 81·235 | + 2·684 | + 57 |
| 3 | 83·92 | − ·001 = | 83·919 | + 2·741 | + 57 |
| 4 | 86·67 | − ·010 = | 86·660 | + 2·798 | + 57 |
| 5 | 89·46 | − ·002 = | 89·458 | + 2·855 | + 57 |
| 6 | 92·31 | + ·003 = | 92·313 | + 2·911 | + 56 |
| 7 | 95·22 | + ·004 = | 95·224 | + 2·969 | + 58 |
| 8 | 98·20 | − ·007 = | 98·193 | + 3·028 | + 59 |
| 9 | 101·22 | + ·001 = | 101·221 | + 3·087 | + 59 |
| 10 | 104·31 | − ·002 = | 104·308 | | |

30. By interpolation the clock readings were found for every tenth of a second. By the help of proportional parts the screen readings were converted into seconds, as follows

I. (1868)[1]

| Screen | $t$ | $\Delta t$ | $\Delta^2 t$ |
|---|---|---|---|
| 1 | 4″·4492 | | |
| | | + 1088 | |
| 2 | 4·5580 | | + 25 |
| | | + 1113 | |
| 3 | 4·6693 | | + 23 |
| | | + 1136 | |
| 4 | 4·7829 | | + 24 |
| | | + 1160 | |
| 5 | 4·8989 | | + 25 |
| | | + 1185 | |
| 6 | 5·0174 | | + 23 |
| | | + 1208 | |
| 7 | 5·1382 | | + 25 |
| | | + 1233 | |
| 8 | 5·2615 | | + 25 |
| | | + 1258 | |
| 9 | 5·3873 | | + 24 |
| | | + 1282 | |
| 10 | 5·5155 | | |

II. (1889)

| Screen | $t$ | $\Delta t$ | $\Delta^2 t$ | $\Delta^3 t$ |
|---|---|---|---|---|
| 1 | 4″·44917 | | | |
| | | + 10885 | | |
| 2 | 4·55802 | | + 239 | |
| | | + 11124 | | 0 |
| 3 | 4·66926 | | + 239 | |
| | | + 11363 | | + 1 |
| 4 | 4·78289 | | + 240 | |
| | | + 11603 | | + 1 |
| 5 | 4·89892 | | + 241 | |
| | | + 11844 | | + 1 |
| 6 | 5·01736 | | + 242 | |
| | | + 12086 | | + 2 |
| 7 | 5·13822 | | + 244 | |
| | | + 12330 | | + 2 |
| 8 | 5·26152 | | + 246 | |
| | | + 12576 | | + 2 |
| 9 | 5·38728 | | + 248 | |
| | | + 12824 | | |
| 10 | 5·51552 | | | |

31. We must now show how the velocity $v$ and the retarding force $f$ of the air upon the shot may be deduced from the results of experiments so expressed.

By Finite differences we have

$$\Delta t_s = t_{s+1} - t_s,$$

or

$$t_{s+1} = t_s + \Delta t_s,$$

$$t_{s+2} = t_{s+1} + \Delta t_{s+1} = t_s + 2\Delta t_s + \Delta^2 t_s,$$

$$t_{s+3} = t_s + 3\Delta t_s + 3\Delta^2 t_s + \Delta^3 t_s,$$

&c. &c.

[1] Ib. p. 30.

And generally

$$t_{s+nl} = t_s + n\Delta t_s + \frac{n \cdot \overline{n-1}}{1 \cdot 2}\Delta^2 t_s + \frac{n \cdot \overline{n-1} \cdot \overline{n-2}}{1 \cdot 2 \cdot 3}\Delta^3 t_s + \&c.$$

$$= t_s + n\{\Delta t_s - \tfrac{1}{2}\Delta^2 t_s + \tfrac{1}{3}\Delta^3 t_s - \tfrac{1}{4}\Delta^4 t_s + \&c.\}$$

$$+ n^2\{\tfrac{1}{2}\Delta^2 t_s - \tfrac{1}{2}\Delta^3 t_s + \tfrac{11}{24}\Delta^4 t_s - \tfrac{10}{24}\Delta^5 t_s + \tfrac{137}{360}\Delta^6 t_s + \&c.\} + \&c.$$

Expanding $t_{s+nl}$ by Taylor's Theorem, we have

$$t_{s+nl} = t_s + \frac{dt_s}{ds}\frac{nl}{1} + \frac{d^2 t_s}{ds^2}\frac{n^2 l^2}{1 \cdot 2} + \frac{d^3 t_s}{ds^3}\frac{n^3 l^3}{1 \cdot 2 \cdot 3} + \&c.,$$

and equating the two coefficients of $n$ and of $n^2$ in the two expansions of $t_{s+nl}$, we have

$$l\frac{dt_s}{ds} = \Delta t_s - \tfrac{1}{2}\Delta^2 t_s + \tfrac{1}{3}\Delta^3 t_s - \tfrac{1}{4}\Delta^4 t_s + \tfrac{1}{5}\Delta^5 t_s - \&c.,$$

and

$$l^2\frac{d^2 t_s}{ds^2} = \Delta^2 t_s - \Delta^3 t_s + \tfrac{11}{12}\Delta^4 t_s - \tfrac{10}{12}\Delta^5 t_s + \tfrac{137}{180}\Delta^6 t_s + \&c.$$

$$= (\Delta^2 t_{s-l} + \Delta^3 t_{s-l}) - (\Delta^3 t_{s-l} + \Delta^4 t_{s-l}) + \tfrac{11}{12}(\Delta^4 t_{s-l} + \Delta^5 t_{s-l})$$

$$- \tfrac{10}{12}(\Delta^5 t_{s-l} + \Delta^6 t_{s-l}) + \tfrac{137}{180}(\Delta^6 t_{s-l} + \Delta^7 t_{s-l}) - \&c.$$

$$= \Delta^2 t_{s-l} - \tfrac{1}{12}\Delta^4 t_{s-l} + \tfrac{1}{12}\Delta^5 t_{s-l} - \tfrac{13}{180}\Delta^6 t_{s-l} - \&c.$$

$$= \Delta^2 t_{s-l} - \tfrac{1}{12}\Delta^4 t_{s-2l} + \tfrac{1}{90}\Delta^6 t_{s-3l} - \&c.$$

32. Also by expanding $t_{s-nl}$ in the same way by Finite Differences and by Taylor's Theorem, it may be shown that

$$l\frac{dt_s}{ds} = \Delta t_{s-l} + \tfrac{1}{2}\Delta^2 t_{s-2l} + \tfrac{1}{3}\Delta^3 t_{s-3l} + \tfrac{1}{4}\Delta^4 t_{s-4l} + \&c.$$

and

$$l^2\frac{d^2 t_s}{ds^2} = \Delta^2 t_{s-2l} + \Delta^3 t_{s-3l} + \tfrac{11}{12}\Delta^4 t_{s-4l} + \tfrac{5}{6}\Delta^5 t_{s-5l} + \&c.$$

33. Let $s$ denote the distance from some fixed point to a screen, $l$ the distance between successive screens, and $t_{s-2l}$, $t_{s-l}$, $t_s$, $t_{s+l}$, $t_{s+2l}$ ... the observed times of the shot passing successive screens. Then if $v_s$ denote the velocity of the shot, and $f_s$ the retarding force of the air upon the shot at the time $t_s$,

$$v_s = \frac{ds}{dt_s} = \frac{l}{\Delta t_s - \tfrac{1}{2}\Delta^2 t_s + \tfrac{1}{3}\Delta^3 t_s - \tfrac{1}{4}\Delta^4 t_s + \tfrac{1}{5}\Delta^5 t_s - \&c.},$$

also

$$= \frac{l}{\Delta t_{s-l} + \tfrac{1}{2}\Delta^2 t_{s-2l} + \tfrac{1}{3}\Delta^3 t_{s-3l} + \tfrac{1}{4}\Delta^4 t_{s-4l} + \tfrac{1}{5}\Delta^5 t_{s-5l} + \&c.},$$

and $$f_s = \frac{d^2s}{dt_s^2} = -\frac{d^2t_s}{ds^2}\left(\frac{ds}{dt_s}\right)^3$$

$$= -\frac{v_s^3}{l^3}(\Delta^2 t_{s-1} - \tfrac{1}{12}\Delta^4 t_{s-2} + \tfrac{1}{90}\Delta^6 t_{s-3} - \&c.).$$

The following scheme explains how these differences are to be taken

$$\begin{array}{llllll}
 & & & +\Delta^3 t_{s-4} & & \\
t_{s-3} & & +\Delta^2 t_{s-3} & & +\Delta^4 t_{s-4} & \\
 & +\Delta t_{s-2} & & +\Delta^3 t_{s-3} & & +\Delta^5 t_{s-4} \\
t_{s-2} & & +\Delta^2 t_{s-2} & & +\Delta^4 t_{s-3} & & +\Delta^6 t_{s-4} \\
 & +\Delta t_{s-1} & & +\Delta^3 t_{s-2} & & +\Delta^5 t_{s-3} & \\
t_s & & +\Delta^2 t_{s-1} & & +\Delta^4 t_{s-2} & & +\Delta^6 t_{s-3} \\
 & +\Delta t_s & & +\Delta^3 t_{s-1} & & +\Delta^5 t_{s-2} & \\
t_{s+1} & & +\Delta^2 t_s & & +\Delta^4 t_{s-1} & & +\Delta^6 t_{s-2} \\
 & +\Delta t_{s+1} & & +\Delta^3 t_s & & +\Delta^5 t_{s-1} & \\
t_{s+2} & & +\Delta^2 l_{s+1} & & +\Delta^4 t_s & & +\Delta^6 t_{s-1} \\
 & +\Delta t_{s+2} & & +\Delta^3 t_{s+1} & & +\Delta^5 t_s & \\
t_{s+3} & & * & & * & & * \\
 & * & & * & & * &
\end{array}$$

34. Let $v_5$ denote the velocity of the shot at the 5th screen, $f_5$ the retarding force at the same point, and $l = 150$ feet, in round 148, then we have

$$v_5 = \frac{150}{\Delta t_s - \frac{1}{2}\Delta^2 t_s + \frac{1}{3}\Delta^3 t_s - \&c.}$$

$$= \frac{150}{\cdot 11844 - \frac{1}{2}\cdot 00242 + \frac{1}{3}\cdot 00002 - \&c.} = 1279{\cdot}5 \text{ f. s.}$$

and $$f_5 = -\frac{v_5^3}{l^3}(\Delta^2 t_{s-1} - \tfrac{1}{12}\Delta^4 t_{s-2} + \&c.)$$

$$= -\frac{v_5^3}{(150)^2}(\cdot 00241) = -2bv_5^3.$$

But when this experiment was made the weight of a cubic foot of air was 534·55 grains, and the standard weight 534·22 grains.

Hence $$K_{v_5} = 2b\,(1000)^3 \frac{w}{d^2}\frac{534{\cdot}22}{534{\cdot}55}$$

$$= \frac{\cdot 00241}{(150)^2}(1000)^3 \frac{23{\cdot}84}{(4{\cdot}92)^2}\frac{534{\cdot}22}{534{\cdot}55} = 105{\cdot}4.$$

In the same way the corresponding values of $v$ and $K_v$ may be found at each screen, as follows

| Screen | $v$ | $\Delta v$ | $\Delta^2 v$ | $K_v$ | $\Delta$ |
|---|---|---|---|---|---|
| | *f. s.* | | | | |
| 2 | 1363·0 | | | 104·5 | |
| | | −28·9 | | | 0 |
| 3 | 1334·1 | | +1·1 | 104·5 | |
| | | −27·8 | | | +·5 |
| 4 | 1306·3 | | +1·0 | 105·0 | |
| | | −26·8 | | | +·4 |
| 5 | 1279·5 | | +1·0 | 105·4 | |
| | | −25·8 | | | +·5 |
| 6 | 1253·7 | | +0·9 | 105·9 | |
| | | −24·9 | | | +·8 |
| 7 | 1228·8 | | +0·7 | 106·7 | |
| | | −24·2 | | | +·9 |
| 8 | 1204·6 | | +0·8 | 107·6 | |
| | | −23·4 | | | +·9 |
| 9 | 1181·2 | | | 108·5 | |

35. Thus round 148 gives the following values of $K_v$

| $v$ | $K_v$ | $v$ | $K_v$ | $v$ | $K_v$ |
|---|---|---|---|---|---|
| *f. s.* | | *f. s.* | | *f. s.* | |
| 1360 | 104·5 | 1300 | 105·1 | 1240 | 106·3 |
| | 0 | | +·1 | | +·4 |
| 1350 | 104·5 | 1290 | 105·2 | 1230 | 106·7 |
| | 0 | | +·2 | | +·3 |
| 1340 | 104·5 | 1280 | 105·4 | 1220 | 107·0 |
| | +·1 | | +·2 | | +·4 |
| 1330 | 104·6 | 1270 | 105·6 | 1210 | 107·4 |
| | +·1 | | +·2 | | +·4 |
| 1320 | 104·7 | 1260 | 105·8 | 1200 | 107·8 |
| | +·1 | | +·2 | | +·4 |
| 1310 | 104·9 | 1250 | 106·0 | 1190 | 108·2 |
| | +·2 | | +·3 | | |

Each of these values of $K_v$ will be found under its proper velocity $v$ in the Summary.

36. The Chronograph when tried with 10 equidistant screens in November and December 1865, in Plumstead Marshes, proved successful. Eighteen rounds in all were fired through ten screens 120 feet apart from the Armstrong 12 Pr. B. L. gun. The diameter of the shot was 3 inches, and its weight about 12 lbs., but no particular care was taken to weigh the shot, as the only object of the experiment was simply to test the working of the instrument. Of the eighteen rounds, two were fired by mistake, while the cylinder was stationary. One shot carried away a screen, and another cut the conducting wire at the second screen. But I was able to give a good account of eleven out of the eighteen rounds fired to test the Chronograph.

37. The following is a statement of the results of this trial experiment, where $d$ denotes the diameter in inches and $w$ the weight of the shot in pounds, and $l$ the distance in feet between successive screens.

Report dated December 18, 1865.

$d = 3$ in., $w = 12$ lbs., $l = 120$ feet.

| Round | Screen 1. | Screen 2. | Screen 3. | Screen 4. | Screen 5. | Screen 6. | Screen 7. | Screen 8. | Screen 9. | Screen 10. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0″·0 | ·10640 | ·21409 | ·32297 | ·43293 | ·54386 | ·65564 | ·76816 | ·88131 | ·99498 |
| 2 | 0·0 | ·10450 | ·20981 | ·31609 | ·42349 | ·53215 | ·64220 | ·75376 | ·86694 | ·98184 |
| 5 | 0·0 | ·10461 | ·21025 | ·31694 | ·42472 | ·53365 | ·64381 | ·75530 | ·86826 | — |
| 7 | 0·0 | ·10335 | ·20872 | ·31567 | ·42386 | ·53305 | ·64310 | ·75398 | ·86577 | ·97866 |
| 10 | 0·0 | ·10540 | ·21164 | ·31891 | ·42732 | ·53694 | ·64786 | ·76008 | ·87360 | ·98842 |
| 11 | 0·0 | ·10467 | ·21096 | ·31877 | ·42800 | ·53855 | ·65032 | ·76321 | — | — |
| 13 | 0·0 | ·10505 | ·21110 | ·31830 | ·42670 | ·53630 | ·64710 | ·75910 | ·87228 | ·98660 |
| 15 | 0·0 | ·10420 | ·21010 | ·31750 | ·42620 | ·53600 | ·64670 | ·75810 | — | — |
| 16 | 0·0 | ·10495 | ·21120 | ·31875 | ·42760 | ·53775 | ·64917 | ·76182 | ·87567 | ·99072 |
| 17 | 0·0 | ·10506 | ·21147 | ·31924 | ·42838 | ·53890 | ·65080 | ·76409 | ·87877 | ·99484 |
| 18 | 0·0 | ·10572 | ·21239 | ·32004 | ·42872 | ·53850 | ·64947 | ·76173 | ·87538 | ·99052 |
| Means | 0·0 | ·10490 | ·21107 | ·31847 | ·42708 | ·53688 | ·64783 | ·75994 | ·87311 | ·98832 |

38. Thus it appears that the average of the mean times of passing each screen was

| Screen | dist. feet | $t$ | $\Delta t$ | $\Delta^2 t$ |
|---|---|---|---|---|
| 1 | 0 | 0″·0000 | | |
| | | | 1049 | |
| 2 | 120 | ·1049 | | 13 |
| | | | 1062 | |
| 3 | 240 | ·2111 | | 12 |
| | | | 1074 | |
| 4 | 360 | ·3185 | | 12 |
| | | | 1086 | |
| 5 | 480 | ·4271 | | 12 |
| | | | 1098 | |
| 6 | 600 | ·5369 | | 11 |
| | | | 1109 | |
| 7 | 720 | ·6478 | | 12 |
| | | | 1121 | |
| 8 | 840 | ·7599 | | 11 |
| | | | 1132 | |
| 9 | 960 | ·8731 | | 20 |
| | | | 1152 | |
| 10 | 1080 | ·9883 | | |

As $\Delta^2 t$ was here found to be nearly constant it was assumed that the space $s$ described in the time $t$ were connected by the equation $t = as + bs^2$, which gives $v = \dfrac{ds}{dt} = \dfrac{1}{a + 2bs}$,

and $$f = \frac{d^2s}{dt^2} = -\frac{2bv}{(a + 2bs)^2} = -2bv^2,$$

or the resistance appeared to vary approximately as the cube of the velocity for this short range.

## CHAPTER III.

### EXPERIMENTS WITH THE CHRONOGRAPH.

39. In the next place, some experiments were authorised to be made at Shoeburyness with elongated projectiles having hemispherical, hemispheroidal, and ogival heads struck with radii of one and of two diameters of the shot. These experiments were carried out on Sept. 25, 26, and 27, 1866. The firing was often interrupted by passing ships, and on the 28th not a single experimental round could be safely fired. As only 44, out of the 70 shots provided were fired, and there was never an opportunity to complete the experiment, the results were not quite so satisfactory as they should have been. But all the hollow ogival headed shot of one and of two diameters were fired alternately, and this constitutes one of the best experiments of the kind ever performed. In order to avoid any confusion in numbering the rounds between the parties on the range and in the observing room it was usual to note at both places the exact time of firing every round. This arrangement enables me to state that the rounds 23—31 were fired in 44 min. 50 sec., and these nine rounds gave 89 good records. The following is a statement of the particulars of each round[1]. The results of these experiments were applied to calculate tables of remaining velocities for each form of shot used. The screens were 150 feet apart.

[1] Reports, &c. 1865—1870, p. 10, and Transactions of the Royal Society, 1868, p. 417.

## 40. Report dated Oct. 23, 1866.

| No. of Round | Weight. | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | lbs. | | | | | | | | | | |
| | | | | | Hemispherical-headed Projectiles. | | | | | | |
| 1 | 39·344 | 0″·0 | ·12639 | ·25467 | ·38481 | ·51678 | ·65055 | ·78609 | ·92337 | 1·06236 | 1·20303 |
| 5 | 39·310 | 0·0 | | | | ·00000 | ·13330 | ·26810 | ·40440 | ·54220 | ·68150 |
| 13 | 39·330 | 0·0 | ·12669 | ·25487 | ·38456 | ·51578 | ·64855 | ·78289 | ·91882 | 1·05636 | 1·19553 |
| 34 | 39·340 | 0·0 | ·12670 | ·25500 | ·38490 | ·51643 | ·64962 | ·78450 | ·92110 | 1·05945 | 1·19958 |
| 43 | 39·340 | 0·0 | ·12596 | ·25361 | ·38297 | ·51406 | ·64690 | ·78151 | ·91791 | 1·05612 | 1·09616 |
| | | | | | Hemispheroidal-headed Projectiles. | | | | | | |
| 2 | 38·72 | 0·0 | ·12662 | ·25444 | ·38352 | ·51392 | ·64570 | ·77892 | ·91364 | * | * |
| 7 | 38·69 | 0·0 | ·12721 | ·25582 | ·38583 | ·51724 | ·65005 | ·78426 | ·91987 | 1·05688 | * |
| 35 | 38·69 | 0·0 | ·12677 | ·25482 | ·38415 | ·51478 | ·64673 | ·78002 | ·91467 | 1·05070 | 1·18813 |
| 40 | 38·69 | 0·0 | ·12640 | ·25416 | ·38329 | ·51380 | ·64570 | ·77900 | ·91370 | 1·04980 | 1·18730 |
| | | | | | Solid Ogival-headed Projectiles (one diameter). | | | | | | |
| 3 | 39·56 | 0·0 | ·12910 | ·25997 | ·39261 | ·52702 | ·66320 | ·80115 | ·94087 | * | * |
| 36 | 39·56 | 0·0 | ·12642 | ·25430 | ·38360 | ·51430 | ·64640 | ·77990 | ·91478 | 1·05100 | * |
| 41 | 39·56 | 0·0 | ·12605 | ·25340 | ·38210 | ·51220 | ·64367 | ·77647 | ·91057 | 1·04597 | 1·18267 |
| | | | | | Solid Ogival-headed Projectiles (two diameters). | | | | | | |
| 4 | 38·56 | 0·0 | ·12655 | ·25461 | ·38414 | ·51510 | ·64746 | ·78119 | ·91626 | 1·05264 | 1·19030 |
| 37 | 38·48 | 0·0 | ·12756 | ·25652 | ·38683 | ·51844 | ·65130 | * | * | * | * |
| 42 | 38·47 | 0·0 | ·12302 | ·24768 | ·37397 | ·50188 | ·63140 | ·76252 | ·89523 | 1·02952 | 1·16538 |
| | | | | | Hollow Ogival-headed Projectiles (one diameter). | | | | | | |
| 14 | 21·78 | 0·0 | ·10010 | ·20276 | ·30795 | ·41565 | ·52585 | ·63855 | ·75374 | ·87140 | ·99150 |
| 16 | 21·81 | 0·0 | ·09850 | ·19926 | ·30247 | ·40824 | ·51662 | ·62762 | ·74124 | ·85748 | ·97634 |
| 18 | 21·81 | 0·0 | ·09930 | ·20114 | ·30552 | ·41244 | ·52189 | ·63386 | ·74834 | ·86532 | ·98479 |
| 20 | 21·83 | 0·0 | ·09900 | ·20072 | ·30505 | ·41190 | ·52120 | ·63290 | ·74699 | ·86346 | ·98230 |
| 22 | 21·81 | 0·0 | ·09892 | ·20019 | ·30382 | ·40983 | ·51825 | ·62912 | ·74248 | ·85837 | ·97683 |
| 24 | 21·83 | 0·0 | ·09953 | ·20157 | ·30613 | ·41322 | ·52285 | ·63503 | ·74977 | ·86708 | ·98697 |
| 26 | 21·81 | 0·0 | ·09975 | ·20205 | ·30687 | ·41418 | ·52395 | ·63615 | ·75075 | ·86772 | ·98703 |
| 28 | 21·83 | 0·0 | ·09900 | ·20048 | ·30444 | ·41088 | ·51981 | ·63123 | ·74514 | ·86154 | ·98043 |
| 30 | 21·81 | 0·0 | ·09947 | ·20147 | ·30600 | ·41306 | ·52265 | ·63477 | ·74942 | ·86660 | ·98631 |
| 32 | 21·81 | 0·0 | ·10379 | ·20989 | ·31833 | ·42915 | ·54240 | ·65814 | ·77644 | ·89738 | 1·02105 |
| | | | | | Hollow Ogival-headed Projectiles (two diameters). | | | | | | |
| 15 | 21·92 | 0·0 | ·09934 | ·20123 | ·30562 | ·41247 | ·52175 | ·63344 | ·74753 | ·86402 | * |
| 19 | 21·94 | 0·0 | ·09829 | ·19913 | ·30257 | ·40866 | ·51745 | ·62899 | * | * | * |
| 21 | 21·89 | 0·0 | ·09951 | ·20143 | ·30575 | ·41246 | ·52155 | ·63301 | ·74683 | ·86300 | ·98151 |
| 23 | 21·89 | 0·0 | ·09857 | ·19949 | ·30277 | ·40842 | ·51645 | ·62687 | ·73969 | ·85492 | * |
| 25 | 21·97 | 0·0 | ·09921 | ·20072 | ·30453 | ·41064 | ·51905 | ·62976 | ·74277 | ·85808 | ·97569 |
| 27 | 21·95 | 0·0 | ·09906 | ·20045 | ·30416 | ·41018 | ·51850 | ·62911 | ·74201 | ·85720 | ·97468 |
| 29 | 21·97 | 0·0 | ·09890 | ·20025 | ·30401 | ·41014 | ·51861 | ·62939 | ·74246 | ·85780 | ·97539 |
| 31 | 21·91 | 0·0 | ·09928 | ·20075 | ·30448 | ·41053 | ·51895 | ·62978 | ·74305 | ·85878 | ·97698 |
| 33 | 21·94 | 0·0 | ·10171 | ·20569 | ·31200 | ·42070 | ·53185 | ·64550 | ·76169 | ·88045 | * |

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### 41. Hemispherical Head.

| | $v=$ | 1160 *f. s.* | 1150 *f. s.* | 1140 *f. s.* | 1130 *f. s.* | 1120 *f. s.* | 1110 *f. s.* | 1100 *f. s.* |
|---|---|---|---|---|---|---|---|---|
| Round 1 | $K_v=$ | 147·3 | 145·8 | 144·2 | 142·7 | 141·2 | 139·5 | 137·9 |
| 5 | $K_v=$ | * | * | * | * | * | 118·7 | 118·7 |
| 13 | $K_v=$ | 120·0 | 121·2 | 122·4 | 123·5 | 124·7 | 125·9 | 127·1 |
| 34 | $K_v=$ | 127·0 | 128·6 | 130·3 | 131·9 | 133·6 | 135·4 | 137·1 |
| 43 | $K_v=$ | 135·9 | 137·0 | 138·0 | 139·0 | 140·0 | 141·1 | * |
| Mean | $K_v=$ | 132·6 | 133·2 | 133·7 | 134·3 | 134·9 | 132·1 | 130·2 |

### 42. Hemispheroidal Head.

| | $v=$ | 1160 *f. s.* | 1150 *f. s.* | 1140 *f. s.* | 1130 *f. s.* | 1120 *f. s.* |
|---|---|---|---|---|---|---|
| Round 2 | $K_v=$ | 101·4 | 105·3 | 109·4 | 113·1 | — |
| 7 | $K_v=$ | 109·1 | 109·1 | 109·1 | 109·1 | — |
| 35 | $K_v=$ | 100·2 | 101·6 | 103·0 | 104·3 | 105·7 |
| 40 | $K_v=$ | 106·9 | 107·6 | 108·3 | 108·8 | 108·8 |
| Mean | $K_v=$ | 104·4 | 105·9 | 107·5 | 108·8 | 107·3 |

### 43. Ogival Head (one diameter) Solid.

| | $v=$ | 1160 *f. s.* | 1150 *f. s.* | 1140 *f. s.* | 1130 *f. s.* | 1120 *f. s.* | 1110 *f. s.* |
|---|---|---|---|---|---|---|---|
| Round 3 | $K_v=$ | * | * | 141·0 | 141·0 | 141·0 | 141·0 |
| 36 | $K_v=$ | 112·1 | 111·3 | 111·3 | 111·3 | 109·9 | * |
| 41 | $K_v=$ | 111·5 | 109·8 | 107·2 | 104·8 | 103·6 | 103·6 |
| Mean | $K_v=$ | 111·8 | 110·6 | 119·8 | 119·0 | 118·2 | 122·3 |

### 44. Ogival Head (two diameters) Solid.

| | $v=$ | 1160 *f. s.* | 1150 *f. s.* | 1140 *f. s.* | 1130 *f. s.* |
|---|---|---|---|---|---|
| Round 4 | $K_v=$ | 113·0 | 110·7 | 108·7 | 106·7 |
| 37 | $K_v=$ | 105·2 | 102·0 | 98·6 | * |
| 42 | $K_v=$ | 124·1 | 123·6 | 123·0 | 122·5 |
| Mean | $K_v=$ | 114·1 | 112·1 | 110·1 | 114·6 |

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45. Ogival Head (one diameter) Hollow.

| | $v=$ | 1460 *f. s.* | 1440 *f. s.* | 1420 *f. s.* | 1400 *f. s.* | 1380 *f. s.* | 1360 *f. s.* | 1340 *f. s.* | 1320 *f. s.* | 1300 *f. s.* |
|---|---|---|---|---|---|---|---|---|---|---|
| Round | | | | | | | | | | |
| 14 | $K_v=$ | * | 110·9 | 110·4 | 110·0 | 109·7 | 109·7 | 109·6 | 109·3 | 108·7 |
| 16 | $K_v=$ | 109·2 | 111·9 | 113·5 | 114·7 | 115·0 | 115·1 | 115·1 | 115·1 | 115·1 |
| 18 | $K_v=$ | * | 111·6 | 111·6 | 111·3 | 111·1 | 110·8 | 110·5 | 110·2 | 109·9 |
| 20 | $K_v=$ | * | 113·0 | 110·8 | 108·9 | 107·3 | 105·7 | 105·3 | 105·0 | 104·7 |
| 22 | $K_v=$ | 103·8 | 104·4 | 105·0 | 105·9 | 107·0 | 108·1 | 109·3 | 110·5 | 111·7 |
| 24 | $K_v=$ | * | 111·0 | 111·2 | 111·5 | 111·8 | 112·1 | 112·3 | 112·6 | 112·9 |
| 26 | $K_v=$ | * | 110·4 | 109·6 | 108·8 | 108·0 | 107·1 | 106·3 | 105·3 | 104·4 |
| 28 | $K_v=$ | 108·9 | 108·9 | 109·0 | 109·3 | 109·4 | 109·4 | 109·4 | 109·4 | 109·4 |
| 30 | $K_v=$ | 111·0 | 111·0 | 111·0 | 111·0 | 111·0 | 111·0 | 111·0 | 111·0 | 111·0 |
| 32 | $K_v=$ | * | * | * | 102·5 | 103·6 | 104·9 | 106·4 | 108·2 | 110·2 |
| Mean | $K_v=$ | 108·2 | 110·3 | 110·2 | 109·4 | 109·4 | 109·4 | 109·5 | 109·7 | 109·8 |

46. Ogival Head (two diameters) Hollow.

| | $v=$ | 1460 *f. s.* | 1440 *f. s.* | 1420 *f. s.* | 1400 *f. s.* | 1380 *f. s.* | 1360 *f. s.* | 1340 *f. s.* | 1320 *f. s.* |
|---|---|---|---|---|---|---|---|---|---|
| Round | | | | | | | | | |
| 15 | $K_v=$ | * | 109·5 | 108·5 | 107·7 | 106·9 | 106·4 | 106·0 | * |
| 21 | $K_v=$ | * | 105·7 | 105·4 | 105·1 | 104·9 | 104·6 | 104·3 | 104·0 |
| 23 | $K_v=$ | 104·2 | 104·5 | 104·7 | 105·0 | 105·3 | 105·6 | 105·9 | * |
| 25 | $K_v=$ | 101·8 | 101·8 | 101·8 | 101·8 | 101·8 | 101·8 | 101·8 | 101·8 |
| 27 | $K_v=$ | 102·6 | 102·3 | 102·0 | 101·7 | 101·4 | 101·3 | * | * |
| 29 | $K_v=$ | 106·5 | 105·5 | 104·5 | 103·7 | 102·8 | 102·0 | 101·4 | 100·7 |
| 31 | $K_v=$ | 99·9 | 101·6 | 103·1 | 104·5 | 105·7 | 106·7 | 107·7 | 108·3 |
| 33 | $K_v=$ | * | * | 103·6 | 105·2 | 107·0 | 108·7 | 110·1 | 111·4 |
| Mean | $K_v=$ | 103·0 | 104·4 | 104·2 | 104·3 | 104·5 | 104·6 | 105·3 | 105·2 |

47. Afterwards an extended series of experiments was authorised to be made at Shoeburyness by the use of my chronograph, which were carried out in 1867, 68. The M. L. guns employed were 3, 5, 7 and 9 inches in calibre; and the projectiles were 2·92, 4·92, 6·92 and 8·92 inches in diameter, their heads being all struck with a radius of one diameter and a half. Their lengths were generally two and a half times the calibres of the guns from which they were fired. Both hollow and solid or cored shot were provided for each gun. The charge of powder was varied in order

to obtain as great a variation in the velocity of the shot as possible. The maximum velocity of 1700 f. s. was at that time considered ample for all practical purposes. The firing was continued till five good rounds were obtained with each charge. The 3, 7 and 9-inch guns were service guns, and to complete the series a bronze gun was bored out to 5 inches and rifled, but it only gave a few good rounds with low charges before it failed. Afterwards a condemned Armstrong B. L. gun was converted into a 5-inch M. L. rifled gun. This imparted a remarkable degree of steadiness to the projectiles, as was shown by the lowness of its coefficients of resistance, and by the great number of records it gave for the rounds fired.

48. Further experiments were carried out with elongated projectiles, in 1878, 9 and again in 1880. The particulars of these three sets of experiments made with ogival-headed shot are here given together, in order to combine all the values of $K$ obtained for each velocity. Rounds 1—240 were fired on thirteen days from Oct. 7, 1867 to May 21, 1868, which were reported July 23, 1868[1] (84/B/1941). Rounds 412—482 were fired on fourteen days from Sept. 13, 1878 to March 12, 1879 which were reported July 8, 1879[2] (84/B/2853); and rounds 483—502 on three days March 8—10, 1880, which were reported Aug. 13, 1880[3] (84/B/2909).

49. Experiments were also carried out by firing both hollow and solid spherical projectiles from the 3, 5, 7 and 9-inch guns on twelve days from May 6 to Nov. 5, 1868. The Report of these experiments was dated, Feb. 13, 1869[4]. The screens were 150 feet apart, except in the few cases noted.

50. The coefficients of resistance were originally reduced for a density of the air such that one cubic foot of air weighed 530·6 grains. But since 1879 the standard density of air has been taken to be that which corresponds to a temperature of 62° Fah., and a height of 30 inches of the Barometer, which give the weight of a cubic foot of dry air 534·22 grains. All the English coefficients have now been adapted to this density.

51. As these experiments are now concluded I have carefully revised all the rounds already published, expressing time to *five* places of decimals of a second—not because time can be really

[1] Reports, &c. 1865—1870, pp. 18—54, and pp. 123—152.
[2] Report, &c., Part II., 1879. [3] Final Report, 1880.
[4] Reports, &c. 1865—1870, pp. 55—122.

measured with such extreme accuracy—but in order to obtain from each round consistent values of $v$ and $K_v$. Thus the reader has placed before him the evidence for the values of $K$ finally adopted. When each group of values of $K$ for a given velocity consisted of numerous experimental determinations of $K$, I have endeavoured to include all *irregular* values of $K$ as far as possible in taking the means. But in the few cases where I have felt obliged to exclude any experimental value of $K$, it has been marked (*).

52. In each case I have been careful to specify here not the date on which any experiment was made—but the date of the Report of my results to Government, which would always be found to be a day or two prior to the date of the official stamp affixed to all documents of this kind when they are received. As the dates of each round have already been given in published Reports, they need not be here repeated, for in all cases of question of priority, the date required is the day when the statement in its definite form left the hands of the experimenter. For so long as any experimenter's results remain in his own possession they are liable to be corrected or modified by him as circumstances may seem to require.

With a view to afford the Secretary of State full and reliable information of the precise value of the results obtained, the Committee, who superintended the experiments with my chronograph, 1867, 8, suggested that their report should be "referred to "mathematicians of eminence, such as the Astronomer Royal, "Professor Adams, Director of the Cambridge Observatory, or "Professor Stokes, Secretary to the Royal Society[1]." After considerable delay the referees sent in a most valuable report, in which they reviewed most of the recent chronoscopes and modes of conducting ballistic experiments. This report was printed[2] in full, but at the time no further notice was taken of it. Shortly afterwards I retired from Her Majesty's Service, but some years after this, being invited to lend my chronograph and complete my experiments, I readily agreed to do so.

[1] Reports, &c. 1870, p. 26.

[2] Ib. pp. 155—161, and Captain Ingalls's Ballistic Machines, p. 25.

Report dated July 23, 1868.

Times at which the Projectiles passed the Screens.

53. (1) 3-inch Gun. Solid Ogival-headed Projectiles.
$w = 12$ lbs.; $d = 2{\cdot}92$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0″·0 | ·12457 | ·25125 | ·38005 | ·51098 | ·64405 | ·77927 | ·91665 | 1·05620 | 1·19793 |
| 2 | 0·0 | ·12244 | ·24659 | ·37241 | ·49986 | ·62890 | ·75949 | ·89160 | 1·02521 | 1·16031 |
| 3 | 0·0 | ·12335 | ·24866 | ·37597 | ·50530 | ·63665 | ·77001 | ·90536 | 1·04267 | 1·18190 |
| 4 | 0·0 | ·12244 | ·24645 | ·37208 | ·49938 | ·62841 | ·75923 | ·89190 | 1·02648 | * |
| 5 | 0·0 | ·12279 | ·24702 | ·37279 | ·50017 | ·62920 | * | * | * | * |
| 49 | 0·0 | ·14400 | ·28909 | ·43528 | ·58258 | ·73100 | ·88054 | 1·03120 | 1·18298 | 1·33588 |
| 50 | 0·0 | ·14570 | ·29244 | ·44032 | ·58943 | ·73986 | ·89168 | 1·04495 | 1·19972 | 1·35603 |
| 52 | 0·0 | ·14356 | ·28847 | ·43470 | ·58221 | ·73097 | ·88095 | 1·03213 | 1·18449 | * |
| 53 | 0·0 | ·14657 | ·29447 | ·44375 | ·59445 | ·74660 | ·90022 | 1·05532 | 1·21190 | * |
| 54 | 0·0 | ·14502 | ·29124 | ·43867 | ·58733 | ·73725 | ·88847 | 1·04104 | * | * |
| 55 | 0·0 | ·19273 | ·38696 | ·58267 | ·77985 | ·97850 | 1·17862 | * | * | * |
| 56 | 0·0 | ·19347 | ·38832 | ·58456 | ·78221 | ·98129 | * | * | * | * |
| 57 | 0·0 | ·19139 | ·38406 | ·57804 | ·77336 | ·97005 | 1·16814 | 1·36767 | 1·56868 | * |
| 59 | 0·0 | ·18913 | ·37983 | ·57213 | ·76607 | ·96168 | 1·15900 | * | * | * |
| 60 | 0·0 | ·19077 | ·38294 | ·57656 | ·77167 | ·96831 | 1·16651 | * | * | * |
| 135 | 0·0 | ·19074 | ·38299 | ·57677 | ·77210 | * | * | * | * | * |
| 137 | 0·0 | ·18694 | ·37528 | ·56506 | ·75632 | ·94910 | 1·14344 | 1·33937 | 1·53692 | * |
| 138 | 0·0 | ·19341 | ·38840 | ·58497 | ·78312 | ·98285 | 1·18416 | * | * | * |

54. Hollow Ogival-headed Projectiles. $w = 9$ lbs.; $d = 2{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 0·0 | ·11395 | ·23077 | ·35052 | ·47329 | ·59920 | * | * | * | * |
| 7 | 0·0 | ·10900 | ·22005 | ·33325 | ·44870 | ·56649 | ·68669 | ·80935 | ·93450 | * |
| 9 | 0·0 | ·11318 | ·22877 | ·34680 | ·46730 | ·59030 | * | * | * | * |
| 10 | 0·0 | ·11193 | ·22634 | ·34325 | ·46269 | ·58469 | ·70928 | ·83649 | * | * |
| 11 | 0·0 | ·10996 | ·22243 | ·33744 | ·45502 | ·57520 | ·69801 | * | * | * |
| 12 | 0·0 | ·11051 | ·22339 | ·33872 | ·45657 | ·57701 | ·70008 | ·82580 | * | * |
| 124 | 0·0 | ·11114 | ·22470 | ·34070 | ·45916 | ·58009 | ·70350 | ·82940 | ·95779 | 1·08867 |
| 126 | 0·0 | ·10865 | ·21978 | ·33337 | ·44941 | ·56790 | ·68885 | ·81228 | ·93822 | 1·06671 |
| 13 | 0·0 | ·13064 | ·26382 | ·39959 | ·53799 | ·67905 | ·82279 | * | * | * |
| 14 | 0·0 | ·13340 | ·26865 | ·40581 | ·54493 | ·68604 | ·82916 | ·97430 | * | * |
| 15 | 0·0 | ·13244 | ·26731 | ·40478 | ·54496 | ·68790 | * | * | * | * |
| 16 | 0·0 | ·13037 | ·26267 | ·39693 | ·53318 | ·67146 | ·81181 | ·95426 | 1·09882 | 1·24549 |
| 17 | 0·0 | ·12765 | ·25754 | ·38970 | ·52416 | ·66095 | ·80010 | ·94164 | * | * |
| 18 | 0·0 | ·12958 | ·26119 | ·39484 | ·53055 | ·66834 | ·80822 | ·95020 | * | * |
| 19 | 0·0 | ·12421 | ·25088 | ·38001 | ·51160 | * | * | * | * | * |
| 26 | 0·0 | ·16784 | ·33701 | ·50751 | ·67935 | ·85254 | 1·02709 | * | * | * |
| 27 | 0·0 | ·17203 | ·34500 | ·51895 | ·69391 | ·86990 | * | * | * | * |
| 28 | 0·0 | ·16971 | ·34072 | ·51304 | ·68668 | ·86165 | 1·03796 | 1·21563 | 1·39468 | * |
| 29 | 0·0 | ·17109 | ·34351 | ·51728 | ·69243 | ·86900 | * | * | * | * |
| 30 | 0·0 | ·17130 | ·34391 | ·51787 | ·69323 | ·87005 | * | * | * | * |
| 31 | 0·0 | ·17187 | ·34505 | ·51955 | ·69538 | ·87255 | * | * | * | * |
| 32 | 0·0 | ·17115 | ·34351 | ·51713 | ·69205 | ·86830 | 1·04590 | * | * | * |

## 55. Hollow Ogival-headed Projectiles. $w = 6$ lbs.; $d = 2{\cdot}92$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 39 | 0″·0 | ·09467 | ·19281 | ·29443 | ·39954 | ·50815 | * | * | * | * |
| 40 | 0·0 | ·09415 | ·19169 | ·29259 | ·39683 | ·50440 | ·61531 | ·72958 | ·84724 | ·96833 |
| 41 | 0·0 | ·09567 | ·19458 | ·29676 | ·40225 | ·51108 | ·62327 | ·73885 | ·85784 | * |
| 43 | 0·0 | ·09795 | ·19931 | ·30408 | ·41227 | ·52388 | ·63892 | ·75741 | ·87936 | 1·00479 |
| 44 | 0·0 | ·09300 | ·18929 | ·28892 | ·39193 | ·49837 | ·60828 | ·72171 | ·83870 | ·95930 |
| 127 | 0·0 | ·09902 | ·20169 | ·30797 | ·41784 | ·53130 | ·64837 | ·76909 | * | * |
| 129 | 0·0 | ·09863 | ·20054 | ·30573 | * | * | * | * | * | * |
| 130 | 0·0 | ·09733 | ·19809 | ·30228 | ·40990 | ·52096 | ·63547 | ·75345 | ·87492 | ·99990 |
| 131 | 0·0 | ·10219 | ·20779 | ·31682 | ·42931 | ·54529 | ·66480 | ·78787 | ·91454 | * |
| 132 | 0·0 | ·09830 | ·19992 | ·30492 | ·41334 | ·52520 | ·64050 | ·75924 | ·88143 | 1·00709 |
| 133 | 0·0 | ·09855 | ·20078 | ·30669 | ·41628 | ·52956 | ·64654 | ·76722 | ·89160 | 1·01968 |
| 134 | 0·0 | ·10249 | ·20883 | ·31902 | ·43307 | ·55099 | ·67280 | ·79852 | * | * |
| 33 | 0·0 | ·11131 | ·22678 | ·34643 | ·47029 | ·59840 | * | * | * | * |
| 34 | 0·0 | ·11298 | ·22889 | ·34780 | ·46978 | * | * | * | * | * |
| 35 | 0·0 | ·11027 | ·22396 | ·34107 | ·46159 | ·58551 | ·71282 | ·84351 | ·97757 | 1·11499 |
| 36 | 0·0 | ·11075 | ·22503 | ·34289 | ·46438 | ·58955 | ·71843 | ·85103 | * | * |
| 37 | 0·0 | ·10979 | ·22325 | ·34038 | ·46118 | ·58566 | ·71383 | * | * | * |
| 38 | 0·0 | ·11181 | ·22709 | ·34587 | ·46817 | ·59402 | ·72344 | ·85645 | ·99308 | 1·13335 |
| 20 | 0·0 | ·14753 | ·29677 | ·44773 | ·60043 | ·75489 | ·91114 | 1·06921 | 1·22912 | 1·39089 |
| 21 | 0·0 | ·14718 | ·29620 | ·44706 | ·59977 | ·75434 | ·91078 | 1·06910 | * | * |
| 23 | 0·0 | ·14240 | ·28724 | ·43456 | ·58439 | ·73676 | ·89170 | * | * | * |
| 24 | 0·0 | ·14572 | ·29374 | ·44406 | ·59668 | ·75160 | ·90883 | 1·06839 | 1·23031 | 1·39462 |
| 25 | 0·0 | ·14554 | ·29318 | ·44294 | ·59483 | ·74887 | ·90507 | 1·06345 | 1·22404 | 1·38688 |

## 56. (2) 5-inch Gun. Cored Ogival-headed Projectiles. $w = 47{\cdot}68$ lbs.; $d = 4{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 164 | 0·0 | ·10995 | ·22112 | ·33352 | ·44716 | ·56205 | ·67820 | ·79561 | ·91428 | 1·03421 |
| 165 | 0·0 | ·11234 | ·22573 | ·34019 | ·45574 | ·57240 | ·69019 | ·80912 | ·92920 | 1·05044 |
| 166 | 0·0 | ·11320 | ·22745 | ·34275 | ·45910 | ·57650 | ·69496 | ·81449 | ·93510 | 1·05680 |
| 167 | 0·0 | ·11194 | ·22500 | ·33919 | ·45451 | ·57097 | ·68858 | ·80735 | ·92728 | 1·04838 |
| 168 | 0·0 | ·11401 | ·22910 | ·34528 | ·46255 | ·58092 | ·70039 | ·82097 | ·94266 | 1·06547 |
| 139 | 0·0 | ·12284 | ·24682 | ·37194 | ·49820 | ·62561 | ·75418 | ·88391 | 1·01480 | 1·14685 |
| 140 | 0·0 | ·12201 | ·24519 | ·36957 | ·49518 | ·62204 | ·75016 | ·87955 | 1·01021 | 1·14214 |
| 141 | 0·0 | ·12192 | ·24511 | ·36959 | ·49537 | ·62247 | ·75090 | ·88066 | 1·01176 | 1·14422 |
| 142 | 0·0 | ·12175 | ·24462 | ·36863 | ·49380 | ·62013 | ·74762 | ·87627 | 1·00609 | 1·13710 |
| 143 | 0·0 | ·12216 | ·24566 | ·37049 | ·49664 | ·62410 | ·75286 | ·88292 | 1·01428 | 1·14694 |
| 169 | 0·0 | ·13336 | ·26776 | ·40324 | ·53984 | ·67759 | ·81651 | ·95661 | 1·09790 | * |
| 170 | 0·0 | ·13124 | ·26371 | ·39741 | ·53234 | ·66850 | ·80589 | ·94450 | 1·08432 | 1·22534 |
| 171 | 0·0 | ·13040 | ·26189 | ·39447 | ·52814 | ·66291 | ·79879 | ·93579 | 1·07392 | 1·21319 |
| 172 | 0·0 | ·12979 | ·26075 | ·39289 | ·52621 | ·66071 | ·79639 | ·93326 | 1·07132 | 1·21057 |
| 173 | 0·0 | ·13082 | ·26275 | ·39580 | ·52998 | ·66529 | ·80174 | ·93933 | 1·07806 | 1·21793 |
| 159 | 0·0 | ·14329 | ·28743 | ·43242 | ·57826 | ·72495 | ·87248 | 1·02085 | 1·17005 | 1·32007 |
| 160 | 0·0 | ·14541 | ·29168 | ·43881 | ·58680 | ·73565 | ·88536 | 1·03593 | 1·18736 | 1·33965 |
| 161 | 0·0 | ·14629 | ·29339 | ·44131 | ·59004 | ·73958 | ·88994 | 1·04112 | 1·19311 | 1·34592 |
| 162 | 0·0 | ·14762 | ·29625 | ·44590 | ·59658 | ·74830 | ·90107 | 1·05490 | 1·20980 | * |
| 163 | 0·0 | ·14520 | ·29111 | ·43773 | ·58506 | ·73310 | ·88185 | 1·03131 | 1·18149 | 1·33239 |

57. Hollow Ogival-headed Projectiles. $w = 23{\cdot}84$ lbs.; $d = 4{\cdot}92$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 144 | 0″·0 | ·08737 | ·17643 | ·26718 | ·35962 | * | * | * | * | * |
| 145 | 0·0 | ·08586 | ·17377 | ·26374 | ·35578 | ·44991 | ·54614 | ·64449 | ·74498 | ·84763 |
| 146 | 0·0 | ·08542 | ·17284 | ·26227 | ·35372 | ·44720 | ·54272 | ·64028 | ·73988 | ·84152 |
| 147 | 0·0 | ·08694 | ·17594 | ·26701 | ·36015 | ·45537 | ·55267 | ·65206 | ·75354 | ·85711 |
| 154 | 0·0 | ·09137 | ·18491 | ·28063 | ·37854 | ·47865 | ·58097 | ·68552 | ·79234 | ·90147 |
| 155 | 0·0 | ·09160 | ·18504 | ·28042 | ·37784 | ·47740 | ·57920 | ·68334 | ·78992 | ·89904 |
| 156 | 0·0 | ·09133 | ·18455 | ·27974 | ·37698 | ·47635 | ·57793 | ·68180 | ·78805 | ·89677 |
| 157 | 0·0 | ·09239 | ·18654 | ·28257 | ·38060 | ·48074 | ·58310 | ·68779 | ·79491 | ·90456 |
| 158 | 0·0 | ·09160 | ·18533 | ·28121 | ·37926 | ·47950 | ·58195 | ·68663 | ·79356 | ·90276 |
| 148 | 0·0 | ·10885 | ·22009 | ·33372 | ·44975 | ·56819 | ·68905 | ·81235 | ·93811 | 1·06635 |
| 149 | 0·0 | ·10793 | ·21842 | ·33149 | ·44715 | ·56540 | ·68624 | ·80967 | ·93568 | 1·06426 |
| 150 | 0·0 | ·10935 | ·22099 | ·33493 | ·45118 | ·56975 | ·69065 | ·81389 | ·93949 | 1·06747 |
| 151 | 0·0 | ·10933 | ·22101 | ·33507 | ·45154 | ·57045 | ·69183 | * | * | * |
| 152 | 0·0 | ·10899 | ·22041 | ·33427 | ·45058 | ·56935 | ·69058 | ·81427 | ·94042 | 1·06903 |
| 153 | 0·0 | ·10729 | ·21691 | ·32886 | ·44314 | ·55975 | ·67869 | ·79997 | ·92359 | 1·04955 |
| 61 | 0·0 | ·11780 | ·23863 | ·36251 | ·48946 | ·61950 | ·75265 | * | * | * |
| 62 | 0·0 | ·11556 | ·23401 | ·35535 | ·47958 | * | * | * | * | * |
| 63 | 0·0 | ·11612 | ·23473 | ·35587 | ·47958 | * | * | * | * | * |
| 64 | 0·0 | ·11673 | ·23596 | ·35767 | ·48184 | ·60845 | ·73748 | ·86893 | 1·00280 | 1·13909 |
| 66 | 0·0 | ·11617 | ·23467 | ·35551 | ·47870 | ·60426 | ·73222 | ·86262 | ·99551 | 1·13095 |
| 67 | 0·0 | ·11661 | ·23567 | ·35715 | ·48103 | ·60731 | ·73600 | ·86711 | 1·00067 | 1·13672 |
| 174 | 0·0 | ·12618 | ·25463 | ·38533 | ·51826 | ·65341 | ·79076 | ·93030 | 1·07202 | 1·21592 |
| 175 | 0·0 | ·13780 | ·27780 | ·41990 | ·56402 | ·71011 | ·85813 | 1·00806 | * | * |
| 176 | 0·0 | ·13321 | ·26840 | ·40557 | ·54471 | ·68581 | ·82886 | ·97385 | * | * |
| 177 | 0·0 | ·16960 | ·34051 | ·51273 | ·68627 | ·86115 | 1·03740 | 1·21506 | * | * |
| 178 | 0·0 | ·16103 | ·32342 | ·48719 | ·65236 | ·81895 | ·98698 | 1·15647 | * | * |

58. (3) 7-inch Gun. Cored Ogival-headed Projectiles. $w = 123{\cdot}125$ lbs.; $d = 6{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 97 | 0·0 | ·11185 | ·22465 | ·33841 | ·45314 | ·56885 | ·68555 | ·80326 | ·92200 | * |
| 98 | 0·0 | ·11054 | ·22205 | ·33455 | ·44806 | ·56260 | ·67819 | ·79485 | ·91260 | 1·03146 |
| 99 | 0·0 | ·10916 | ·21922 | ·33019 | ·44207 | ·55487 | ·66860 | ·78328 | ·89893 | 1·01557 |
| 100 | 0·0 | ·10940 | ·21974 | ·33104 | ·44332 | ·55660 | ·67091 | ·78627 | ·90270 | 1·02022 |
| 101 | 0·0 | ·11467 | ·23039 | ·34718 | ·46506 | ·58405 | * | * | * | * |
| 86 | 0·0 | ·12305 | ·24691 | ·37160 | ·49714 | ·62355 | * | * | * | * |
| 87 | 0·0 | ·12232 | ·24564 | ·36996 | ·49528 | ·62160 | ·74892 | ·87724 | 1·00657 | 1·13692 |
| 88 | 0·0 | ·12380 | ·24863 | ·37451 | ·50146 | ·62949 | ·75860 | ·88878 | 1·02002 | 1·15230 |
| 89 | 0·0 | ·12331 | ·24758 | ·37281 | * | * | * | * | * | * |
| 91 | 0·0 | ·12591 | ·25275 | ·38049 | ·50910 | ·63856 | ·76885 | ·89995 | 1·03185 | 1·16454 |
| 92 | 0·0 | ·12330 | ·24739 | ·37227 | ·49794 | * | * | * | * | * |
| 93 | 0·0 | ·12515 | ·25157 | ·37924 | ·50814 | ·63825 | ·76955 | ·90202 | 1·03563 | 1·17035 |
| 103 | 0·0 | ·15018 | ·30102 | ·45251 | ·60464 | ·75740 | ·91078 | 1·06477 | 1·21936 | 1·37454 |
| 104 | 0·0 | ·15138 | ·30335 | ·45590 | ·60902 | * | * | * | * | * |
| 105 | 0·0 | ·14941 | ·29960 | ·45055 | ·60224 | ·75465 | ·90776 | 1·06156 | 1·21604 | * |

59. Hollow Ogival-headed Projectiles. $w = 61{\cdot}156$ lbs.; $d = 6{\cdot}92$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 113 | 0″·0 | ·09199 | ·18565 | ·28101 | ·37810 | ·47694 | ·57754 | ·67991 | ·78406 | * |
| 114 | 0·0 | ·09303 | ·18782 | ·28440 | ·38280 | ·48305 | ·58518 | ·68921 | ·79516 | * |
| 115 | 0·0 | ·09147 | ·18474 | ·27984 | ·37680 | ·47565 | * | * | * | * |
| 116 | 0·0 | ·09333 | ·18834 | ·28503 | ·38339 | ·48341 | ·58508 | ·68839 | ·79333 | ·89989 |
| 117 | 0·0 | ·09193 | ·18552 | ·28079 | ·37776 | ·47646 | ·57692 | * | * | * |
| 94 | 0·0 | ·11213 | ·22604 | ·34177 | ·45936 | ·57885 | ·70028 | ·82368 | ·94907 | 1·07646 |
| 96 | 0·0 | ·10988 | ·22187 | ·33599 | ·45226 | ·57068 | ·69125 | * | * | * |
| 110 | 0·0 | ·11100 | ·22421 | ·33966 | ·45738 | ·57740 | * | * | * | * |
| 111 | 0·0 | ·11138 | ·22486 | ·34046 | ·45820 | ·57810 | ·70018 | ·82446 | * | * |
| 112 | 0·0 | ·11192 | ·22573 | ·34149 | ·45924 | ·57900 | ·70079 | ·82463 | ·95054 | 1·07854 |
| 121 | 0·0 | ·17071 | ·34313 | ·51725 | ·69306 | ·87055 | 1·04971 | * | * | * |
| 122 | 0·0 | ·17178 | ·34522 | ·52031 | ·69704 | ·87540 | 1·05539 | 1·23701 | 1·42026 | * |

60. (4) 9-inch Gun. Cored Ogival-headed Projectiles. $w = 250$ lbs.; $d = 8{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 218 | 0·0 | ·11523 | ·23124 | ·34803 | ·46560 | ·58395 | ·70308 | ·82300 | ·94371 | 1·06521 |
| 219 | 0 0 | ·11549 | ·23166 | ·34854 | ·46616 | ·58455 | ·70375 | ·82381 | ·94478 | * |
| 220 | 0·0 | ·11590 | ·23271 | ·35041 | ·46898 | ·58839 | ·70861 | ·82961 | ·95136 | 1·07383 |
| 221 | 0·0 | ·11496 | ·23076 | ·34740 | ·46488 | ·58320 | ·70236 | ·82237 | ·94323 | 1·06494 |
| 228 | 0·0 | ·11674 | ·23441 | ·35298 | ·47243 | ·59274 | ·71389 | ·83587 | ·95867 | * |
| 229 | 0·0 | ·11876 | ·23812 | ·35808 | ·47864 | ·59980 | ·72156 | ·84392 | ·96688 | * |
| 239 | 0·0 | ·11872 | ·23804 | ·35798 | ·47856 | ·59979 | ·72169 | ·84428 | ·96758 | 1·09161 |
| 240 | 0·0 | ·12060 | ·24185 | ·36375 | ·48630 | ·60951 | ·73339 | ·85795 | ·98321 | 1·10920 |
| 208 | 0·0 | ·12522 | ·25121 | ·37796 | ·50546 | ·63370 | ·76267 | ·89237 | 1·02280 | 1·15396 |
| 209 | 0·0 | ·12464 | ·24999 | ·37605 | ·50282 | ·63029 | ·75846 | ·88732 | 1·01687 | * |
| 210 | 0·0 | ·12407 | ·24882 | ·37425 | ·50035 | ·62713 | ·75459 | ·88273 | * | * |
| 211 | 0·0 | ·12517 | ·25125 | ·37823 | ·50609 | ·63481 | ·76436 | ·89471 | 1·02582 | * |
| 212 | 0·0 | ·12560 | ·25181 | ·37864 | ·50609 | ·63417 | ·76289 | ·89227 | 1·02232 | 1·15306 |
| 232 | 0·0 | ·13428 | ·26942 | ·40541 | ·54224 | ·67990 | ·81838 | ·95768 | * | * |
| 233 | 0·0 | ·13390 | ·26887 | ·40491 | ·54202 | * | * | * | * | * |
| 234 | 0·0 | ·13401 | ·26855 | ·40366 | ·53938 | ·67575 | ·81281 | ·95060 | 1·08916 | * |
| 235 | 0·0 | ·13516 | ·27084 | ·40704 | ·54377 | ·68104 | ·81886 | ·95725 | 1·09623 | * |
| 236 | 0·0 | ·13362 | ·26803 | ·40323 | ·53922 | ·67601 | ·81362 | ·95208 | 1·09142 | 1·23168 |
| 237 | 0·0 | ·13448 | ·26977 | ·40587 | ·54277 | ·68046 | ·81894 | ·95821 | 1·09827 | 1·23912 |
| 238 | 0·0 | ·13412 | ·26899 | ·40462 | ·54103 | ·67824 | ·81627 | ·95514 | 1·09487 | 1·23548 |
| 222 | 0·0 | ·15369 | ·30781 | ·46237 | ·61738 | ·77285 | ·92879 | 1·08521 | 1·24212 | * |
| 223 | 0·0 | ·15327 | ·30717 | ·46170 | ·61686 | ·77266 | ·92911 | 1·08622 | 1·24401 | 1·40250 |
| 224 | 0·0 | ·15287 | ·30635 | ·46047 | ·61526 | ·77074 | ·92693 | 1·08385 | 1·24152 | 1·39996 |
| 225 | 0·0 | ·15486 | ·31049 | ·46688 | ·62403 | ·78194 | ·94061 | 1·10003 | * | * |
| 226 | 0·0 | ·15304 | ·30667 | ·46091 | ·61579 | ·77133 | ·92755 | * | * | * |
| 227 | 0·0 | ·15539 | ·31135 | ·46789 | ·62502 | ·78277 | ·94118 | 1·10030 | 1·26019 | * |

61. Hollow Ogival-headed Projectiles. $w = 125$ lbs.; $d = 8{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 0·0 | ·14203 | ·28707 | ·43512 | * | * | * | * | * | * |
| 213 | 0·0 | ·17402 | ·35024 | ·52866 | * | * | * | * | * | * |
| 214 | 0·0 | ·17620 | ·35453 | ·53499 | ·71757 | ·90226 | * | * | * | * |

Report dated Feb. 13, 1869.

Times at which the Projectiles passed the Screens.

62. (1) 3-inch Gun. Solid Spherical Projectiles.

$w = 3{\cdot}316$ lbs.; $d = 2{\cdot}92$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 284 | 0″·0 | ·07184 | ·14980 | ·23389 | ·32410 | * | * | * | * | * |
| 285 | 0·0 | ·07294 | ·15215 | ·23806 | ·33110 | ·43170 | ·54028 | ·65725 | ·78302 | ·91800 |
| 286 | 0·0 | ·07062 | ·14698 | ·22963 | ·31912 | ·41601 | ·52086 | ·63423 | ·75668 | * |
| 287 | 0·0 | ·07170 | ·14937 | ·23347 | ·32446 | ·42281 | ·50900 | ·62352 | ·74687 | ·87956 |
| 288 | 0·0 | ·07592 | ·15801 | ·24677 | ·34270 | ·44631 | ·55810 | ·67858 | ·80825 | ·94762 |
| 290 | 0·0 | ·08388 | ·17483 | ·27329 | ·37970 | ·49448 | ·61798 | ·75048 | ·89219 | 1·04325 |
| 291 | 0·0 | ·07691 | ·16011 | ·25008 | ·34730 | ·45225 | ·56540 | ·68722 | ·81818 | ·95874 |
| 292 | 0·0 | ·08361 | ·17437 | ·27270 | ·37897 | ·49350 | ·61655 | ·74833 | ·88900 | 1·03867 |
| 293 | 0·0 | ·07932 | ·16572 | ·25929 | ·36011 | * | * | * | * | * |
| 294 | 0·0 | ·07821 | ·16311 | ·25510 | ·35459 | ·46200 | ·57776 | ·70231 | * | * |
| 295 | 0·0 | ·08312 | ·17320 | ·27070 | ·37608 | ·48979 | ·61228 | ·74400 | ·88540 | * |
| 296 | 0·0 | ·08225 | ·17166 | ·26863 | ·37355 | ·48681 | ·60879 | ·73986 | * | * |
| 297 | 0·0 | ·08183 | ·17096 | ·26771 | ·37240 | ·48535 | ·60688 | ·73731 | * | * |
| 312 | 0·0 | ·08442 | ·17644 | ·27637 | ·38451 | ·50115 | ·62657 | ·76104 | ·89482 | * |
| 261 | 0·0 | ·12310 | ·25571 | ·39738 | ·54773 | ·70646 | ·87336 | * | * | * |
| 262 | 0·0 | ·12460 | ·25812 | ·40033 | ·55104 | ·71009 | ·87736 | 1·05276 | * | * |
| 263 | 0·0 | ·12318 | ·25554 | ·39677 | ·54655 | ·70456 | ·87048 | 1·04399 | * | * |
| 264 | 0·0 | ·11669 | ·24255 | ·37732 | ·52076 | ·67266 | ·83284 | 1·00116 | 1·17752 | 1·36186 |
| 266 | 0·0 | ·12536 | ·25987 | ·40326 | * | * | * | * | * | * |
| 267 | 0·0 | ·12046 | ·25079 | ·39027 | ·53821 | * | * | * | * | * |
| 268 | 0·0 | ·15270 | ·31383 | ·48337 | ·66130 | ·84760 | * | * | * | * |
| 269 | 0·0 | ·13915 | ·28619 | ·44124 | ·60443 | ·77590 | ·95580 | 1·14429 | * | * |
| 270 | 0·0 | ·12822 | ·26517 | ·41085 | ·56526 | ·72840 | * | * | * | * |
| 271 | 0·0 | ·13572 | ·28001 | ·43270 | ·59362 | ·76260 | ·93947 | 1·12405 | * | * |
| 272 | 0·0 | ·14167 | ·29124 | ·44888 | ·61477 | ·78910 | ·97207 | * | * | * |
| 273 | 0·0 | ·13753 | ·28347 | ·43745 | ·59910 | * | * | * | * | * |

63. Hollow Spherical Projectiles. $w = 2$ lbs.; $d = 2{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 310 | 0·0 | ·07226 | ·15304 | ·24534 | ·35123 | ·47185 | ·60741 | ·75718 | ·91949 | * |
| 311 | 0·0 | ·07149 | ·15327 | ·24658 | ·35305 | ·47391 | ·60958 | ·75964 | ·92318 | * |
| 281 | 0·0 | ·09060 | ·19443 | ·31194 | ·44356 | ·58970 | ·75075 | * | * | * |
| 282 | 0·0 | ·11458 | ·24393 | ·38742 | ·54442 | ·71429 | ·89638 | 1·09004 | * | * |
| 283 | 0·0 | ·09013 | ·19353 | ·31024 | * | * | * | * | * | * |
| 299 | 0·0 | ·07816 | ·16795 | ·27023 | ·38586 | ·51570 | * | * | * | * |
| 300 | 0·0 | ·09936 | ·21333 | ·34157 | ·48373 | ·63945 | ·80837 | ·99012 | * | * |
| 301 | 0·0 | ·07729 | ·16520 | ·26556 | ·37963 | ·50811 | ·65115 | ·80837 | ·97887 | 1·16124 |
| 277 | 0·0 | ·11958 | ·25372 | ·40171 | ·56286 | ·73650 | * | * | * | * |
| 279 | 0·0 | ·11549 | ·24592 | ·39048 | ·54836 | * | * | * | * | * |
| 302 | 0·0 | ·09346 | ·20110 | ·32296 | ·45908 | ·60950 | ·77426 | * | * | * |
| 303 | 0·0 | ·09221 | ·19822 | ·31857 | ·45347 | ·60278 | ·76597 | ·94214 | 1·13004 | 1·32808 |
| 304 | 0·0 | ·09274 | ·19968 | ·32098 | ·45680 | ·60730 | * | * | * | * |
| 274 | 0·0 | ·17092 | ·35481 | ·55005 | ·75502 | * | * | * | * | * |
| 275 | 0·0 | ·18342 | ·37606 | ·57907 | ·79360 | * | * | * | * | * |
| 308 | 0·0 | ·12551 | ·26565 | ·41962 | ·58662 | * | * | * | * | * |
| 309 | 0·0 | ·12540 | ·26580 | ·42044 | ·58855 | ·76933 | ·96193 | * | * | * |

## 64. (2) 5-inch Gun. Solid Spherical Projectiles.

$w = 15{\cdot}789$ lbs.; $d = 4{\cdot}92$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 407 | 0″·0 | ·07452 | ·15252 | ·23432 | ·32024 | * | * | * | * | * |
| 408 | 0·0 | ·07814 | ·16030 | ·24664 | ·33732 | ·43251 | ·53238 | ·63710 | ·74683 | ·86173 |
| 409 | 0·0 | ·06918 | ·14195 | ·21847 | ·29884 | ·38314 | ·47147 | ·56399 | ·66098 | ·76291 |
| 410 | 0·0 | ·06822 | ·14003 | ·21558 | ·29502 | ·37849 | ·46613 | ·55807 | ·65444 | ·75537 |
| 411 | 0·0 | ·06927 | ·14206 | ·21851 | ·29876 | ·38296 | ·47126 | ·56381 | * | * |
| 315 | 0·0 | ·07980 | ·16385 | ·25227 | ·34518 | ·44269 | ·54491 | ·65195 | * | * |
| 316 | 0·0 | ·08212 | ·16834 | ·25878 | ·35359 | ·45295 | ·55707 | ·66618 | ·78053 | ·90039 |
| 317 | 0·0 | ·07982 | ·16372 | ·25188 | ·34449 | ·44174 | ·54382 | ·65091 | ·76318 | ·88079 |
| 318 | 0·0 | ·09417 | ·19278 | ·29583 | ·40332 | ·51525 | * | * | * | * |
| 380 | 0·0 | ·07848 | ·16069 | ·24689 | ·33734 | ·43229 | ·53199 | ·63669 | ·74663 | ·86205 |
| 381 | 0·0 | ·08017 | ·16423 | ·25235 | ·34471 | ·44149 | ·54287 | ·64902 | ·76011 | ·87630 |
| 382 | 0·0 | ·09119 | ·18674 | ·28690 | ·39191 | ·50200 | ·61739 | ·73829 | ·86491 | ·99746 |
| 383 | 0·0 | ·09078 | ·18561 | ·28508 | ·38978 | ·50030 | * | * | * | * |
| 385 | 0·0 | ·08680 | ·17754 | ·27247 | ·37186 | ·47600 | ·58519 | ·69974 | ·81996 | ·94616 |
| 386 | 0·0 | ·08817 | ·18031 | ·27688 | ·37830 | ·48492 | ·59700 | ·71467 | ·83789 | ·96641 |
| 387 | 0·0 | ·08788 | ·18011 | ·27687 | ·37834 | ·48470 | ·59613 | ·71280 | * | * |
| 388 | 0·0 | ·09636 | ·19724 | ·30278 | ·41312 | ·52840 | ·64875 | * | * | * |
| 389 | 0·0 | ·09625 | ·19685 | ·30209 | ·41226 | ·52763 | ·64846 | ·77500 | ·90750 | * |
| 390 | 0·0 | ·09533 | ·19495 | ·29942 | ·40929 | ·52510 | * | * | * | * |
| 392 | 0·0 | ·09583 | ·19598 | ·30086 | ·41090 | ·52655 | * | * | * | * |

## 65. Hollow Spherical Projectiles. $w = 7{\cdot}894$ lbs.; $d = 4{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 394 | 0·0 | ·06508 | ·13692 | ·21622 | ·30367 | ·39995 | ·50573 | ·62167 | ·74842 | * |
| 395 | 0·0 | ·06332 | ·13282 | ·20930 | ·29356 | ·38639 | ·48857 | ·60087 | ·72405 | * |
| 396 | 0·0 | ·06266 | ·13165 | ·20774 | ·29161 | ·38425 | ·48616 | ·59815 | ·72095 | ·85529 |
| 397 | 0·0 | ·06355 | ·13354 | ·21061 | ·29540 | * | * | * | * | * |
| 398 | 0·0 | ·06172 | ·13141 | ·20910 | ·29482 | ·38858 | ·49038 | ·60022 | ·71810 | * |
| 399 | 0·0 | ·06278 | ·13209 | ·20863 | ·29310 | ·38619 | ·48858 | ·60094 | ·72393 | ·85820 |
| 400 | 0·0 | ·06521 | ·13732 | ·21692 | ·30461 | ·40100 | ·50671 | ·62237 | * | * |
| 401 | 0·0 | ·06236 | ·13127 | ·20741 | ·29145 | ·38405 | ·48587 | ·59756 | ·71978 | ·85319 |
| 320 | 0·0 | ·07762 | ·16322 | ·25746 | ·36100 | ·47451 | ·59867 | ·73416 | ·88166 | * |
| 321 | 0·0 | ·07680 | ·16159 | ·25499 | ·35762 | ·47010 | * | * | * | * |
| 322 | 0·0 | ·07769 | ·16288 | ·25666 | ·36012 | * | * | * | * | * |
| 323 | 0·0 | ·07574 | ·15963 | ·25226 | ·35421 | ·46605 | ·58835 | ·72168 | ·86661 | * |
| 324 | 0·0 | ·07616 | ·16036 | ·25322 | ·35537 | ·46745 | ·59011 | * | * | * |
| 325 | 0·0 | ·07681 | ·16120 | ·25398 | ·35595 | ·46790 | ·59061 | * | * | * |
| 402 | 0·0 | ·07657 | ·16082 | ·25355 | ·35556 | ·46765 | ·59062 | * | * | * |
| 403 | 0·0 | ·07870 | ·16534 | ·26065 | ·36537 | ·48026 | ·60608 | ·74359 | ·89355 | * |
| 404 | 0·0 | ·07564 | ·15895 | ·25065 | ·35146 | ·46211 | ·58333 | * | * | * |
| 405 | 0·0 | ·07655 | ·16075 | ·25359 | ·35607 | ·46920 | * | * | * | * |
| 406 | 0·0 | ·07597 | ·15955 | ·25154 | ·35273 | ·46390 | ·58582 | * | * | * |

## 66. (3) 7-inch Gun. Solid Spherical Projectiles. $w = 44{\cdot}094$ lbs.; $d = 6{\cdot}92$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 326 | 0″·0 | ·08417 | ·17110 | ·26107 | ·35436 | ·45125 | ·55202 | * | * | * |
| 327 | 0·0 | ·08409 | ·17124 | ·26154 | ·35507 | ·45190 | ·55209 | ·65571 | ·76282 | ·87349 |
| 329 | 0·0 | ·08673 | ·17631 | ·26889 | ·36463 | ·46370 | ·56627 | ·67250 | ·78255 | * |
| 330 | 0·0 | ·08412 | ·17125 | ·26144 | ·35475 | ·45124 | ·55097 | ·65400 | ·76039 | * |
| 341 | 0·0 | ·08431 | ·17168 | ·26221 | ·35600 | ·45315 | ·55376 | ·65793 | ·76577 | ·87739 |
| 373 | 0·0 | ·08552 | ·17406 | ·26571 | ·36055 | ·45866 | ·56011 | ·66498 | ·77336 | ·88534 |
| 379 | 0·0 | ·08547 | ·17415 | ·26607 | ·36127 | ·45979 | ·56168 | ·66699 | ·77577 | ·88808 |
| 331 | 0·0 | ·09281 | ·18900 | ·28863 | ·39175 | ·49840 | ·60862 | * | * | * |
| 332 | 0·0 | ·09285 | ·18910 | ·28875 | ·39180 | ·49826 | ·60813 | * | * | * |
| 334 | 0·0 | ·09353 | ·19016 | ·28999 | ·39313 | ·49969 | ·60979 | * | * | * |
| 336 | 0·0 | ·09343 | ·19010 | ·29011 | ·39356 | ·50054 | ·61115 | ·72548 | ·84361 | ·96561 |
| 342 | 0·0 | ·09241 | ·18816 | ·28731 | ·38992 | ·49606 | ·60581 | * | * | * |
| 343 | 0·0 | ·09226 | ·18806 | ·28740 | ·39029 | ·49672 | ·60668 | ·72016 | * | * |
| 337 | 0·0 | ·11053 | ·22480 | ·34285 | ·46473 | ·59049 | ·72017 | ·85381 | ·99145 | 1·13312 |
| 338 | 0·0 | ·12033 | ·24458 | ·37276 | ·50487 | ·64090 | * | * | * | * |
| 339 | 0·0 | ·12482 | ·25382 | ·38689 | ·52393 | ·66484 | ·80953 | ·95790 | 1·10985 | * |
| 344 | 0·0 | ·11235 | ·22853 | ·34860 | ·47262 | ·60065 | ·73275 | ·86897 | 1·00935 | * |
| 345 | 0·0 | ·11343 | ·23054 | ·35148 | ·47639 | ·60541 | ·73867 | * | * | * |
| 353 | 0·0 | ·14380 | ·29083 | ·44122 | ·59509 | ·75255 | ·91370 | 1·07863 | 1·24741 | 1·42010 |
| 354 | 0·0 | ·14585 | ·29504 | ·44768 | ·60387 | ·76370 | ·92725 | 1·09459 | * | * |
| 355 | 0·0 | ·16081 | ·32433 | ·49151 | ·66289 | ·83861 | 1·01838 | 1·20151 | * | * |
| 356 | 0·0 | ·15464 | ·31210 | ·47309 | ·63802 | ·80700 | ·97985 | 1·15610 | * | * |
| 357 | 0·0 | ·14087 | ·28567 | ·43445 | ·58726 | ·74415 | * | * | * | * |

## 67. Hollow Spherical Projectiles. $w = 22{\cdot}047$ lbs.; $d = 6{\cdot}92$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 346 | 0·0 | ·08645 | ·17875 | ·27741 | ·38293 | ·49580 | * | * | * | * |
| 347 | 0·0 | ·08485 | ·17569 | ·27296 | ·37711 | ·48860 | * | * | * | * |
| 349 | 0·0 | ·08534 | ·17644 | ·27388 | ·37826 | ·49021 | ·61040 | * | * | * |
| 350 | 0·0 | ·08473 | ·17545 | ·27255 | ·37641 | ·48740 | ·60589 | ·73225 | ·86685 | * |
| 351 | 0·0 | ·08780 | ·18186 | ·28255 | ·39024 | ·50530 | ·62810 | ·75901 | * | * |
| 352 | 0·0 | ·08530 | ·17698 | ·27528 | ·38043 | ·49267 | * | * | * | * |
| 365 | 0·0 | ·08881 | ·18402 | ·28599 | ·39508 | ·51165 | * | * | * | * |
| 366 | 0·0 | ·08716 | ·18045 | ·28034 | ·38724 | ·50150 | ·62343 | ·75332 | ·89146 | * |
| 367 | 0·0 | ·09480 | ·19626 | ·30476 | ·42068 | ·54440 | ·67630 | * | * | * |
| 368 | 0·0 | ·09536 | ·19750 | ·30669 | ·42322 | ·54740 | * | * | * | * |
| 369 | 0·0 | ·09506 | ·19684 | ·30553 | ·42153 | ·54545 | ·67811 | ·82054 | ·97398 | * |
| 370 | 0·0 | ·09525 | ·19717 | ·30618 | ·42262 | ·54675 | ·67875 | ·81871 | ·96663 | * |
| 371 | 0·0 | ·09468 | ·19600 | ·30421 | ·41957 | ·54236 | ·67287 | ·81140 | * | * |
| 372 | 0·0 | ·09444 | ·19524 | ·30299 | ·41814 | ·54102 | ·67185 | ·81077 | ·95785 | * |
| 374 | 0·0 | ·09247 | ·19173 | ·29801 | ·41153 | ·53249 | ·66109 | ·79752 | ·94196 | 1·09458 |
| 375 | 0·0 | ·08807 | ·18226 | ·28287 | ·39020 | ·50456 | ·62626 | * | * | * |
| 376 | 0·0 | ·09333 | ·19295 | ·29928 | ·41275 | ·53379 | ·66282 | ·80025 | ·94648 | * |
| 377 | 0·0 | ·09692 | ·20102 | ·31252 | ·43164 | ·55859 | ·69357 | ·83677 | * | * |
| 378 | 0·0 | ·08971 | ·18601 | ·28919 | ·39954 | ·51736 | ·64295 | ·77662 | ·91868 | * |
| 360 | 0·0 | ·10942 | ·22612 | ·35036 | ·48240 | ·62250 | * | * | * | * |
| 363 | 0·0 | ·10800 | ·22382 | ·34751 | ·47905 | ·61835 | ·76523 | ·91942 | 1·08056 | * |
| 364 | 0·0 | ·09995 | ·20620 | ·31931 | ·43981 | ·56820 | * | * | * | * |

## 68. (4) 9-inch Gun. Solid Spherical Projectiles. $w = 94{\cdot}5$ lbs.; $d = 8{\cdot}888$ inches.

| No. of Round | 1 Sc. | 2 Screen. | 3 Screen. | 4 Screen. | 5 Screen. | 6 Screen. | 7 Screen. | 8 Screen. | 9 Screen. | 10 Screen. |
|---|---|---|---|---|---|---|---|---|---|---|
| 253 | 0″0 | ·07805 | ·15818 | ·24043 | ·32485 | ·41148 | ·50035 | ·59148 | ·68489 | ·78059 |
| 255 | 0·0 | ·07719 | ·15653 | ·23802 | ·32167 | ·40748 | ·49545 | ·58557 | ·67783 | ·77222 |
| 257 | 0·0 | ·08017 | ·16218 | ·24617 | ·33227 | ·42059 | ·51124 | ·60432 | ·69993 | ·79817 |
| 258 | 0·0 | ·08021 | ·16231 | ·24640 | ·33258 | ·42095 | ·51161 | ·60466 | ·70019 | ·79829 |
| 259 | 0·0 | ·07961 | ·16131 | ·24510 | ·33098 | ·41898 | ·50913 | ·60148 | ·69608 | ·79300 |
| 260 | 0·0 | ·08015 | ·16206 | ·24591 | ·33187 | ·42010 | ·51074 | ·60392 | ·69974 | ·79827 |
| 204 | 0·0 | ·08885 | ·18018 | ·27404 | ·37047 | ·46949 | ·57112 | ·67538 | ·78228 | ·89182 |
| 205 | 0·0 | ·08673 | ·17575 | ·26707 | ·36071 | ·45669 | ·55503 | * | * | * |
| 206 | 0·0 | ·08907 | ·18050 | ·27454 | ·37097 | ·46989 | ·57133 | ·67531 | ·78183 | ·89090 |
| 241 | 0·0 | ·08801 | ·17841 | ·27121 | ·36640 | ·46399 | ·56397 | ·66633 | ·77107 | * |
| 242 | 0·0 | ·09022 | ·18284 | ·27792 | ·37552 | ·47569 | ·57849 | ·68396 | ·79216 | ·90313 |
| 243 | 0·0 | ·08914 | ·18060 | ·27443 | ·37068 | ·46940 | ·57064 | ·67445 | ·78087 | ·88995 |
| 244 | 0·0 | ·08950 | ·18130 | ·27546 | ·37204 | ·47110 | ·57270 | ·67690 | ·78376 | ·89334 |
| 245 | 0·0 | ·08779 | ·17783 | ·27021 | ·36500 | ·46227 | ·56209 | ·66454 | ·76970 | ·87765 |
| 179 | 0·0 | ·09729 | ·19714 | ·29957 | ·40459 | ·51221 | ·62244 | ·73527 | ·85069 | ·96870 |
| 180 | 0·0 | ·09712 | ·19691 | ·29937 | ·40448 | ·51221 | ·62254 | ·73547 | ·85100 | ·96915 |
| 181 | 0·0 | ·09799 | ·19849 | ·30155 | ·40723 | ·51560 | ·62673 | ·74070 | ·85756 | ·97733 |
| 182 | 0·0 | ·09831 | ·19918 | ·30267 | ·40884 | ·51775 | ·62943 | ·74388 | ·86113 | ·98121 |
| 183 | 0·0 | ·09608 | ·19459 | ·29559 | ·39915 | ·50534 | ·61423 | ·72589 | ·84038 | * |
| 184 | 0·0 | ·12202 | ·24689 | ·37462 | ·50523 | ·63875 | ·77521 | ·91464 | 1·05706 | 1·20248 |
| 185 | 0·0 | ·13617 | ·27488 | ·41614 | ·55996 | ·70634 | ·85528 | 1·00678 | 1·16083 | * |
| 187 | 0·0 | ·12312 | ·24946 | ·37894 | ·51148 | ·64700 | ·78541 | ·92662 | 1·07053 | * |
| 189 | 0·0 | ·13121 | ·26522 | ·40204 | ·54168 | ·68415 | ·82945 | ·97758 | 1·12855 | 1·28236 |
| 190 | 0·0 | ·12599 | ·25478 | ·38638 | ·52080 | ·65805 | ·79814 | * | * | * |
| 191 | 0·0 | ·12830 | ·25946 | ·39350 | ·53044 | ·67030 | ·81310 | ·95887 | 1·10763 | * |
| 192 | 0·0 | ·13156 | ·26577 | ·40265 | ·54222 | ·68449 | ·82947 | ·97718 | 1·12765 | 1·28092 |

## 69. Hollow Spherical Projectiles. $w = 67{\cdot}5$ lbs.; $d = 8{\cdot}886$ inches.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 248 | 0·0 | ·07497 | ·15262 | ·23306 | ·31651 | ·40310 | ·49296 | ·58620 | ·68291 | ·78316 |
| 249 | 0·0 | ·07793 | ·15888 | ·24290 | ·33004 | ·42035 | ·51389 | ·61071 | ·71086 | * |
| 251 | 0·0 | ·07555 | ·15415 | ·23580 | ·32051 | ·40828 | ·49911 | ·59300 | ·68996 | * |
| 246 | 0·0 | ·08794 | ·17919 | ·27388 | ·37214 | ·47410 | ·57990 | ·68969 | ·80362 | ·92185 |
| 247 | 0·0 | ·08728 | ·17768 | ·27135 | ·36845 | ·46914 | ·57357 | ·68189 | ·79424 | ·91076 |
| 252 | 0·0 | ·08777 | ·17891 | ·27354 | ·37177 | ·47371 | ·57946 | ·68911 | ·80273 | ·92037 |
| 254 | 0·0 | ·08648 | ·17643 | ·26987 | ·36684 | ·46740 | ·57162 | ·67957 | ·79132 | ·90694 |
| 256 | 0·0 | ·08798 | ·17933 | ·27407 | ·37226 | ·47400 | ·57944 | ·68877 | ·80222 | * |
| 193 | 0·0 | ·10513 | ·21416 | ·32710 | ·44396 | ·56475 | ·68948 | ·81816 | ·95080 | 1·08741 |
| 194 | 0·0 | ·10431 | ·21256 | ·32476 | ·44092 | ·56107 | ·68524 | ·81345 | ·94572 | 1·08206 |
| 195 | 0·0 | ·10401 | ·21186 | ·32359 | ·43926 | ·55895 | ·68274 | ·81069 | ·94284 | 1·07921 |
| 196 | 0·0 | ·10788 | ·21978 | ·33572 | ·45573 | ·57985 | ·70812 | ·84057 | ·97722 | 1·11808 |
| 197 | 0·0 | ·11108 | ·22583 | ·34427 | ·46641 | ·59225 | ·72178 | ·85500 | ·99193 | 1·13261 |
| 198 | 0·0 | ·14273 | ·28919 | ·43942 | ·59345 | ·75130 | ·91298 | 1·07850 | 1·24787 | * |
| 199 | 0·0 | ·14482 | ·29332 | ·44551 | ·60140 | ·76101 | ·92437 | 1·09151 | 1·26247 | * |
| 200 | 0·0 | ·14483 | ·29322 | ·44521 | ·60084 | ·76013 | ·92308 | 1·08969 | 1·25998 | 1·43399 |
| 201 | 0·0 | ·12838 | ·26021 | ·39549 | * | * | * | * | * | * |
| 202 | 0·0 | ·14670 | ·29679 | ·45033 | ·60741 | ·76815 | ·93266 | 1·10103 | 1·27333 | 1·44961 |
| 203 | 0·0 | ·14453 | ·29263 | ·44436 | ·59977 | ·75890 | ·92178 | 1·08843 | 1·25888 | 1·43317 |

## Report dated July 8, 1879.

### 70. Times at which the Elongated Projectiles passed the Screens.

| Form of Head | *w* lbs. | *d* inch. | No. of Round | Screens 150 feet apart. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Ogival | 70·0 | 6·0 | 461 | 0″·0 | ·07710 | ·15520 | ·23425 | ·31421 | ·39505 | ·47675 | ·55930 | ·64270 | * | * | * |
| ,, | 70·0 | ,, | 462 | 0·0 | ·07752 | ·15608 | ·23570 | ·31640 | ·39820 | ·48110 | ·56510 | ·65019 | ·73634 | ·82353 | ·91174 |
| ,, | 70·0 | ,, | 463 | 0·0 | ·07724 | ·15539 | ·23446 | ·31447 | ·39542 | ·47731 | ·56014 | ·64392 | ·72866 | ·81437 | ·90106 |
| Flat | 70·0 | ,, | 464 | 0·0 | ·07873 | ·15948 | ·24225 | ·32704 | ·41384 | ·50265 | ·59347 | ·68630 | ·78114 | * | * |
| ,, | 70·0 | ,, | 465 | 0·0 | ·07909 | ·16024 | ·24346 | ·32877 | ·41619 | ·50575 | ·59749 | ·69144 | ·78763 | ·88608 | ·98682 |
| ,, | 70·0 | ,, | 466 | 0·0 | ·07934 | ·16061 | ·24394 | ·32940 | ·41702 | ·50680 | ·59871 | ·69271 | ·78874 | ·88675 | ·98669 |
| Hemi-spherical | 70·0 | ,, | 467 | 0·0 | ·07918 | ·15963 | ·24135 | ·32435 | ·40863 | ·49419 | ·58103 | ·66915 | ·75855 | ·84923 | ·94119 |
| | 70·0 | ,, | 468 | 0·0 | ·07942 | ·15978 | ·24116 | ·32364 | ·40731 | ·49227 | ·57860 | ·66636 | ·75559 | ·84632 | ·93858 |
| ,, | 70·0 | ,, | 469 | 0·0 | ·07847 | ·15829 | ·23947 | ·32201 | ·40592 | ·49120 | ·57785 | ·66587 | ·75526 | ·84601 | ·93812 |
| Ogival | 70·0 | ,, | 470 | 0·0 | ·08439 | ·16987 | ·25641 | ·34398 | ·43256 | ·52212 | ·61264 | ·70408 | ·79641 | ·88960 | ·98362 |
| ,, | 70·0 | ,, | 471 | 0·0 | ·08491 | ·17061 | ·25713 | ·34450 | ·43276 | * | * | * | * | * | * |
| ,, | 70·0 | ,, | 472 | 0·0 | ·08554 | ·17205 | ·25955 | ·34806 | ·43761 | ·52821 | ·61986 | ·71256 | ·80631 | ·90111 | * |
| ,, | 50·0 | ,, | 473 | 0·0 | ·06987 | ·14104 | ·21348 | ·28717 | ·36208 | ·43818 | ·51546 | ·59390 | ·67347 | ·75414 | * |
| ,, | 50·0 | ,, | 474 | 0·0 | ·06904 | ·13925 | ·21063 | ·28318 | ·35691 | ·43183 | ·50794 | ·58524 | ·66374 | ·74345 | * |
| ,, | 50·0 | ,, | 475 | 0·0 | ·06918 | ·13951 | ·21102 | ·28375 | ·35773 | ·43297 | ·50944 | ·58711 | ·66594 | ·74590 | * |
| ,, | 50·0 | ,, | 476 | 0·0 | ·06950 | ·14012 | ·21187 | ·28476 | ·35879 | ·43396 | ·51028 | ·58775 | ·66636 | ·74611 | * |
| ,, | 50·0 | ,, | 477 | 0·0 | ·06877 | ·13869 | ·20977 | ·28202 | ·35545 | ·43006 | ·50585 | ·58280 | ·66090 | ·74013 | * |
| ,, | 50·0 | ,, | 478 | 0·0 | ·06679 | ·13466 | ·20362 | ·27368 | ·34483 | ·41707 | ·49039 | ·56478 | * | * | * |
| ,, | 50·0 | ,, | 479 | 0·0 | ·06659 | ·13427 | ·20305 | ·27292 | ·34388 | ·41593 | ·48907 | ·56331 | ·63865 | ·71509 | ·79263 |
| ,, | 50·0 | ,, | 480 | 0·0 | ·06596 | ·13299 | ·20110 | ·27029 | ·34056 | ·41192 | ·48436 | ·55789 | ·63250 | ·70820 | * |
| ,, | 50·0 | ,, | 481 | 0·0 | ·06660 | ·13429 | ·20306 | ·27290 | ·34380 | ·41575 | ·48874 | ·56276 | ·63780 | ·71385 | ·79090 |
| ,, | 50·0 | ,, | 482 | 0·0 | ·06565 | ·13244 | ·20038 | ·26947 | ·33969 | ·41102 | ·48344 | ·55692 | ·63144 | ·70699 | ·78356 |

## 71. Times at which the Ogival-headed Projectiles passed the Screens.

| $w$ lbs. | $d$ inches. | No. of Round | Screens 75 feet apart. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 6·50 | 2·97 | 412 | 0″·0 | ·07144 | ·14382 | ·21709 | ·29120 | ·36609 | ·44170 | ·51799 | ·59492 | ·67242 | ·75041 | ·82884 | ·90766 | ·98683 | 1·06629 | 1·14598 |
| 6·50 | ,, | 413 | 0·0 | ·06957 | ·13986 | ·21085 | ·28250 | ·35478 | ·42765 | ·50107 | ·57501 | ·64946 | ·72442 | ·79988 | ·87584 | ·95229 | 1·02922 | 1·10662 |
| 6·50 | ,, | 414 | 0·0 | ·07174 | ·14420 | ·21735 | ·29117 | ·36562 | ·44067 | ·51628 | ·59241 | ·66903 | ·74614 | ·82374 | ·90184 | ·98045 | 1·05958 | * |
| 6·50 | ,, | 415 | 0·0 | ·07813 | ·15690 | ·23629 | ·31628 | ·39684 | ·47797 | ·55968 | ·64200 | ·72496 | ·80857 | ·89283 | ·97775 | 1·06333 | 1·14957 | * |
| 6·56 | ,, | 416 | 0·0 | ·07598 | ·15226 | ·22888 | ·30586 | ·38322 | ·46101 | ·53928 | ·61804 | ·69729 | ·77705 | ·85734 | ·93819 | 1·01963 | 1·10170 | 1·18443 |
| 6·50 | ,, | 417 | 0·0 | ·07588 | ·15226 | ·22914 | ·30652 | ·38440 | ·46279 | ·54171 | ·62118 | ·70121 | ·78183 | ·86307 | ·94496 | 1·02754 | 1·11086 | 1·19497 |
| 6·44 | ,, | 418 | 0·0 | ·07882 | ·15824 | ·23830 | ·31904 | ·40050 | ·48269 | ·56561 | ·64924 | ·73355 | ·81850 | ·90405 | * | * | * | * |
| 6·50 | ,, | 419 | 0·0 | ·07763 | ·15570 | ·23421 | ·31316 | ·39256 | ·47242 | ·55275 | ·63358 | ·71495 | ·79691 | ·87949 | ·96269 | 1·04651 | 1·13095 | * |
| 6·47 | ,, | 421 | 0·0 | ·08304 | ·16620 | ·24955 | ·33315 | ·41707 | ·50139 | ·58617 | ·67147 | ·75736 | ·84390 | ·93116 | 1·01922 | 1·10815 | 1·19803 | * |
| 6·56 | ,, | 422 | 0·0 | ·08175 | ·16421 | ·24737 | ·33122 | ·41574 | ·50090 | ·58665 | ·67293 | ·75968 | ·84683 | ·93430 | 1·02202 | 1·10994 | 1·19802 | * |
| 6·47 | ,, | 423 | 0·0 | ·08467 | ·16964 | ·25492 | ·34052 | ·42645 | ·51273 | ·59939 | ·68647 | ·77401 | ·86203 | ·95055 | 1·03959 | 1·12917 | * | * |
| 6·66 | ,, | 424 | 0·0 | ·09667 | ·19397 | ·29190 | ·39046 | ·48964 | ·58944 | ·68986 | ·79086 | ·89240 | ·99449 | 1·09712 | 1·20032 | 1·30407 | 1·40838 | 1·51324 |
| 6·56 | ,, | 425 | 0·0 | ·09426 | ·18897 | ·28416 | ·37986 | ·47610 | ·57292 | ·67035 | ·76841 | ·86713 | ·96654 | 1·06667 | 1·16754 | 1·26918 | 1·37142 | 1·47489 |
| 6·63 | ,, | 426 | 0·0 | ·10255 | ·20569 | ·30942 | ·41374 | ·51866 | ·62419 | ·73034 | ·83715 | ·94468 | 1·05299 | 1·16213 | 1·27214 | 1·38307 | 1·49506 | 1·60796 |
| 6·47 | ,, | 427 | 0·0 | ·09203 | ·18455 | ·27756 | ·37106 | ·46504 | ·55951 | ·65448 | ·74996 | ·84597 | ·94252 | 1·03961 | * | * | * | * |
| 6·63 | ,, | 428 | 0·0 | ·09434 | ·18916 | ·28447 | ·38027 | ·47657 | ·57339 | ·67074 | ·76862 | ·86703 | ·96598 | 1·06547 | 1·16550 | 1·26607 | 1·36718 | 1·46883 |
| 6·47 | ,, | 429 | 0·0 | ·08501 | ·17051 | ·25650 | ·34299 | ·43000 | ·51754 | ·60564 | ·69433 | ·78361 | ·87349 | ·96396 | 1·05502 | 1·14667 | 1·23892 | * |
| 6·47 | ,, | 430 | 0·0 | ·08791 | ·17629 | ·26514 | ·35445 | ·44422 | ·53445 | ·62514 | ·71629 | ·80789 | ·89995 | ·99246 | 1·08543 | 1·17887 | 1·27279 | 1·36720 |

| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6·63 | ,, | 432 | 0·0 | ·10486 | ·21016 | ·31592 | ·42217 | ·52894 | ·63626 | ·74416 | ·85266 | * | * | * | * | * | * | * |
| 6·56 | ,, | 433 | 0·0 | ·10572 | ·21219 | ·31940 | ·42736 | ·53607 | ·64553 | ·75574 | ·86669 | ·97837 | 1·09078 | 1·20392 | 1·31778 | 1·43236 | 1·54766 | * |
| 6·63 | ,, | 434 | 0·0 | ·10213 | ·20500 | ·30861 | ·41295 | ·51801 | ·62378 | ·73025 | ·83741 | ·94525 | 1·05377 | 1·16297 | 1·27285 | 1·38340 | 1·49462 | * |
| 6·56 | ,, | 435 | 0·0 | ·10238 | ·20558 | ·30959 | ·41440 | ·52001 | ·62642 | ·73363 | ·84164 | ·95045 | 1·06006 | 1·17047 | 1·28167 | 1·39366 | 1·50644 | 1·62001 |
| 6·63 | ,, | 436 | 0·0 | ·10754 | ·21580 | ·32478 | ·43449 | ·54495 | ·65619 | ·76822 | ·88104 | ·99463 | 1·10896 | 1·22402 | 1·33979 | 1·45625 | * | * |
| 6·63 | ,, | 437 | 0·0 | ·10758 | ·21594 | ·32508 | ·43500 | ·54570 | ·65718 | ·76943 | ·88245 | ·99624 | 1·11080 | 1·22612 | 1·34219 | 1·45901 | 1·57658 | * |
| 6·63 | ,, | 438 | 0·0 | ·12421 | ·24961 | ·37614 | ·50374 | ·63235 | ·76192 | ·89239 | 1·02371 | 1·15583 | 1·28871 | 1·42231 | 1·55658 | 1·69147 | * | * |
| 6·31 | ,, | 439 | 0·0 | ·12901 | ·25878 | ·38931 | ·52060 | ·65266 | ·78549 | ·91909 | 1·05346 | 1·18862 | 1·32458 | 1·46136 | 1·59899 | 1·73749 | 1·87687 | 2·01713 |
| 6·34 | ,, | 440 | 0·0 | ·12506 | ·25080 | ·37724 | ·50441 | ·63234 | ·76105 | ·89056 | 1·02089 | 1·15205 | 1·28404 | 1·41687 | 1·55054 | 1·68506 | 1·82044 | 1·95669 |
| 6·31 | ,, | 441 | 0·0 | ·12681 | ·25439 | ·38274 | ·51186 | ·64174 | ·77238 | ·90377 | 1·03590 | 1·16876 | 1·30235 | 1·43667 | 1·57172 | 1·70749 | 1·84399 | 1·98121 |
| 6·53 | ,, | 442 | 0·0 | ·12999 | ·26090 | ·39273 | ·52548 | ·65914 | ·79371 | ·92919 | 1·06559 | 1·20292 | 1·34117 | 1·48034 | 1·62043 | 1·76144 | 1·90338 | 2·04625 |
| 6·41 | ,, | 443 | 0·0 | ·09762 | ·19593 | ·29493 | ·39462 | ·49498 | ·59599 | ·69763 | 0·79990 | 0·90280 | 1·00633 | 1·11049 | 1·21529 | 1.32073 | 1·42682 | 1·53357 |
| 6·41 | ,, | 444 | 0·0 | ·09584 | ·19224 | ·28921 | ·38675 | ·48487 | ·58356 | ·68282 | 0·78265 | 0·88305 | 0·98403 | 1·08559 | 1·18772 | 1·29042 | 1·39369 | 1·49754 |
| 6·34 | ,, | 445 | 0·0 | ·10086 | ·20228 | ·30425 | ·40677 | ·50985 | ·61350 | ·71773 | 0·82254 | 0·92794 | 1·03392 | 1·14049 | 1·24765 | 1·35539 | 1·46371 | 1·57261 |
| 6·41 | ,, | 446 | 0·0 | ·09505 | ·19066 | ·28682 | ·38353 | ·48079 | ·57861 | ·67699 | 0·77593 | 0·87544 | 0·97552 | 1·07617 | 1·17739 | 1·27918 | 1·38153 | 1·48443 |
| 6·41 | ,, | 447 | 0·0 | ·10224 | ·20510 | ·30858 | ·41268 | ·51740 | ·62274 | ·72871 | 0·83532 | 0·94257 | 1·05047 | 1·15903 | 1·26825 | 1·37814 | 1·48871 | 1·59996 |
| 6·31 | ,, | 448 | 0·0 | ·12423 | ·24911 | ·37465 | ·50086 | ·62775 | ·75534 | ·88365 | 1·01269 | 1·14246 | 1·27297 | 1·40423 | 1·53625 | 1·66905 | 1·80265 | 1·93707 |
| 70·0 | 6·27 | 449 | 0·0 | ·12250 | ·24511 | ·36785 | ·49074 | ·61381 | ·73709 | ·86064 | 0·98452 | 1·10879 | 1·23351 | 1·35874 | 1·48453 | 1·61091 | 1·73788 | 1·86544 |
| 70·0 | ,, | 450 | 0·0 | ·12356 | ·24746 | ·37170 | ·49628 | ·62120 | ·74648 | ·87214 | 0·99824 | 1·12484 | 1·25199 | 1·37972 | 1·50803 | 1·63690 | 1·76631 | 1·89624 |
| 70·0 | ,, | 451 | 0·0 | ·12300 | ·24641 | ·37022 | ·49443 | ·61904 | ·74404 | ·86942 | 0·99517 | 1·12128 | 1·24774 | 1·37454 | 1·50167 | 1·62911 | 1·75684 | 1·88484 |
| 70·0 | ,, | 452 | 0·0 | ·13557 | ·27148 | ·40773 | ·54433 | ·68129 | ·81861 | ·95630 | 1·09473 | 1·23281 | 1·37163 | 1·51083 | 1·65041 | 1·79038 | 1·93074 | 2·07150 |
| 70·0 | ,, | 453 | 0·0 | ·13749 | ·27530 | ·41344 | ·55193 | ·69079 | ·83003 | ·96967 | 1·10971 | 1·25016 | 1·39103 | 1·53232 | 1·67402 | 1·81613 | 1·95864 | 2·10153 |
| 70·0 | ,, | 454 | 0·0 | ·15676 | ·31410 | ·47202 | ·63052 | ·78960 | ·94926 | 1·10948 | 1·27025 | 1·43157 | 1·59344 | 1·75586 | 1·91883 | 2·08233 | 2·24633 | 2·41078 |
| 70·0 | ,, | 455 | 0·0 | ·16863 | ·33788 | ·50777 | ·67832 | ·84954 | 1·02143 | 1·19400 | 1·36726 | 1·54123 | 1·71594 | 1·89141 | 2·06766 | 2·24471 | * | * |
| 70·0 | ,, | 456 | 0·0 | ·15658 | ·31356 | ·47094 | ·62872 | ·78690 | 0·94548 | 1·10445 | 1·26379 | 1·42349 | 1·58354 | 1·74395 | 1·90473 | 2·06590 | 2·22748 | 2·38947 |
| 70·0 | ,, | 457 | 0·0 | ·16916 | ·33871 | ·50866 | ·67902 | ·84980 | 1·02101 | 1·19264 | 1·36469 | 1·53716 | 1·71005 | 1·88336 | 2·05709 | 2·23124 | * | * |
| 70·0 | ,, | 458 | 0·0 | ·15475 | ·31012 | ·46611 | ·62271 | ·77990 | 0·93767 | 1·09600 | 1·25487 | 1·41426 | 1·57416 | 1·73455 | 1·89542 | 2·05675 | 2·21853 | * |
| 70·0 | ,, | 459 | 0·0 | ·16965 | ·33977 | ·51036 | ·68142 | ·85295 | 1·02494 | 1·19740 | 1·37032 | 1·54371 | 1·71757 | 1·89189 | 2·06666 | 2·24188 | * | * |

Report dated Aug. 31, 1880.

72. Times at which the Ogival-headed Projectiles passed the Screens.

| *w* lbs. | *d* inches. | No of Round | Screens 150 feet apart. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 80·0 | 8·0 | 483 | 0″·0 | ·05389 | ·10871 | ·16447 | ·22118 | ·27884 | ·33746 | ·39705 | ·45761 | ·51914 | ·58164 | * |
| ,, | ,, | 484 | 0·0 | ·05338 | ·10779 | ·16322 | ·21967 | * | * | * | * | * | * | * |
| ,, | ,, | 485 | 0·0 | ·05379 | ·10893 | ·16536 | ·22302 | ·28185 | ·34179 | ·40278 | ·46478 | ·52777 | ·59173 | ·65665 |
| ,, | ,, | 486 | 0·0 | ·05355 | ·10805 | ·16351 | ·21993 | ·27731 | ·33565 | ·39494 | ·45518 | ·51636 | ·57848 | ·64154 |
| ,, | ,, | 487 | 0·0 | ·05347 | ·10791 | ·16331 | ·21967 | ·27699 | ·33528 | ·39455 | ·45481 | ·51607 | ·57835 | ·64167 |
| ,, | ,, | 488 | 0·0 | ·05410 | ·10915 | ·16515 | ·22211 | ·28003 | ·33890 | ·39871 | ·45945 | ·52112 | ·58372 | ·64726 |
| ,, | ,, | 489 | 0·0 | ·05782 | ·11653 | ·17614 | ·23664 | ·29803 | * | * | * | * | * | * |
| ,, | ,, | 490 | 0·0 | ·06367 | ·12848 | ·19443 | ·26151 | ·32973 | ·39908 | ·46957 | ·54121 | ·61401 | * | * |
| ,, | ,, | 491 | 0·0 | ·06156 | ·12448 | ·18875 | ·25436 | ·32128 | ·38948 | ·45894 | ·52965 | ·60161 | ·67482 | ·74929 |
| ,, | ,, | 492 | 0·0 | ·06186 | ·12487 | ·18903 | ·25434 | ·32079 | ·38836 | ·45703 | ·52679 | ·59763 | ·66954 | ·74251 |
| ,, | ,, | 493 | 0·0 | ·06111 | ·12353 | ·18726 | ·25231 | ·31868 | ·38637 | ·45537 | ·52567 | ·59726 | ·67013 | ·74427 |
| ,, | ,, | 494 | 0·0 | ·06083 | ·12278 | ·18586 | ·25008 | ·31545 | ·38198 | ·44969 | ·51860 | ·58873 | ·66010 | ·73273 |
| ,, | ,, | 495 | 0·0 | ·06287 | ·12665 | ·19138 | ·25709 | ·32382 | ·39158 | ·46040 | ·53030 | ·60129 | ·67338 | * |
| ,, | ,, | 496 | 0·0 | ·05358 | ·10812 | ·16362 | ·22008 | ·27751 | ·33590 | ·39525 | ·45557 | ·51688 | ·57918 | ·64248 |
| ,, | ,, | 497 | 0·0 | ·06511 | ·13158 | ·19942 | ·26864 | ·33925 | ·41125 | ·48465 | ·55945 | ·63564 | ·71322 | * |
| ,, | ,, | 498 | 0·0 | ·06232 | ·12591 | ·19078 | ·25695 | ·32444 | ·39326 | ·46341 | ·53489 | ·60770 | ·68185 | * |
| ,, | ,, | 499 | 0·0 | ·06296 | ·12718 | ·19266 | ·25941 | ·32742 | ·39669 | ·46721 | ·53897 | ·61197 | ·68621 | * |
| ,, | ,, | 500 | 0·0 | ·06432 | ·12998 | ·19697 | ·26527 | ·33487 | ·40578 | ·47801 | ·55156 | ·62645 | ·70269 | * |
| ,, | ,, | 501 | 0·0 | ·06540 | ·13187 | ·19941 | ·26802 | ·33770 | ·40845 | ·48028 | ·55320 | ·62722 | ·70234 | ·77856 |
| ,, | ,, | 502 | 0·0 | ·07029 | ·14171 | ·21427 | ·28798 | ·36285 | ·43890 | ·51615 | ·59460 | ·67425 | ·75509 | ·83713 |

## 73. Report dated February 13, 1869.

| Round | $K_v$ |
|---|---|
| 720 *f. s.* | |
| 275 | 119·2 |
| 740 *f. s.* | |
| 275 | 113·2 |
| 760 *f. s.* | |
| 274 | 105·8 |
| 275 | 107·2 |
| Mean | 106·5 |
| 780 *f. s.* | |
| Mean | 106·8 |
| 800 *f. s.* | |
| 274 | 120·9 |
| 282 | 120·3 |
| 303 | 113·4 |
| Mean | 118·2 |
| 820 *f. s.* | |
| Mean | 128·2 |
| 840 *f. s.* | |
| 264 | 137·4 |
| 268 | 144·1 |
| 269 | 145·9 |
| 271 | 133·5 |
| 274 | 133·3 |
| 282 | 125·3 |
| 303 | 124·8 |
| 309 | 127·2 |
| 355 | 160·2* |
| Mean | 133·9 |
| 860 *f. s.* | |
| Mean | 136·4 |
| 880 *f. s.* | |
| 200 | 139·1 |
| 202 | 147·9 |
| 203 | 143·7 |
| 262 | 139·9 |
| 263 | 132·7 |
| 264 | 138·6 |
| 268 | 144·4 |
| 269 | 143·3 |
| 271 | 136·6 |
| 272 | 145 3 |
| 282 | 129·8 |
| 300 | 133·1 |
| 301 | 125·1 |
| 303 | 132·9 |
| 309 | 132·7 |
| 353 | 157·4 |
| 355 | 173·1* |
| 356 | 158·4 |
| Mean | 140·0 |
| 900 *f. s.* | |
| Mean | 141·7 |
| 920 *f. s.* | |
| 198 | 144·3 |
| 199 | 141·6 |
| 200 | 137·5 |
| 202 | 142·3 |
| 203 | 141·4 |
| 261 | 138·8 |
| 262 | 141·3 |
| 263 | 137·7 |
| 264 | 140·3 |
| 268 | 144·7 |
| 269 | 141·1 |
| 270 | 150·1 |
| 271 | 139·3 |
| 272 | 142·4 |
| 277 | 131·9 |
| 282 | 133·7 |
| 300 | 135·3 |
| 301 | 137·6 |
| 303 | 138·6 |
| 309 | 137·3 |
| 353 | 152·2 |
| 354 | 150·7 |
| 355 | 126·6 |
| 356 | 160·0 |
| Mean | 141·1 |
| 940 *f. s.* | |
| Mean | 141·0 |
| 960 *f. s.* | |
| 198 | 143·6 |
| 199 | 139·5 |
| 200 | 137·2 |
| 202 | 134·2 |
| 203 | 139·5 |
| 261 | 141·7 |
| 262 | 143·0 |
| 263 | 142·1 |
| 264 | 142·2 |
| 269 | 139·2 |
| 270 | 150·1 |
| 271 | 141·7 |
| 272 | 139·8 |
| 273 | 133·2 |
| 277 | 135·6 |
| 282 | 137·1 |
| 300 | 137·1 |
| 301 | 142·6 |
| 302 | 147·2 |
| 303 | 142·8 |
| 308 | 136·5 |
| 309 | 141·3 |
| 311 | 139·8 |
| 353 | 145·3 |
| 354 | 144·9 |
| 356 | 118·1* |
| 363 | 141·5 |
| Mean | 140·7 |
| 980 *f. s.* | |
| Mean | 141·7 |
| 1000 *f. s.* | |
| 185 | 131·6 |
| 189 | 149·4 |
| 192 | 145·9 |
| 198 | 142·2 |
| 199 | 138·7 |
| 200 | 135·2 |
| 202 | 128·5 |
| 203 | 136·6 |
| 261 | 145·2 |
| 262 | 144·9 |
| 263 | 146·0 |
| 264 | 144·5 |
| 269 | 137·4 |
| 1000 *f. s.* *continued.* | |
| 270 | 150·1 |
| 271 | 143·9 |
| 272 | 137·5 |
| 273 | 138·2 |
| 277 | 138·9 |
| 279 | 138·9 |
| 281 | 153·7 |
| 282 | 140·2 |
| 300 | 138·9 |
| 301 | 146·2 |
| 302 | 147·0 |
| 303 | 145·6 |
| 308 | 140·3 |
| 309 | 144·8 |
| 310 | 138·8 |
| 311 | 144·1 |
| 339 | 142·1 |
| 353 | 137·1 |
| 354 | 137·7 |
| 357 | 161·9 |
| 363 | 147·7 |
| 374 | 163·1 |
| Mean | 142·9 |
| 1020 *f. s.* | |
| Mean | 144·0 |
| 1040 *f. s.* | |
| 185 | 131·6 |
| 189 | 148·8 |
| 191 | 156·2 |
| 192 | 142·7 |
| 261 | 149·0 |
| 262 | 146·9 |
| 263 | 149·6 |
| 264 | 146·8 |
| 269 | 135·8 |
| 270 | 150·1 |
| 271 | 145·9 |
| 273 | 142·7 |
| 277 | 141·9 |
| 279 | 142·5 |
| 281 | 152·1 |
| 282 | 142·9 |
| 290 | 158·5 |
| 292 | 153·1 |
| 300 | 140·4 |
| 301 | 148·2 |
| 1040 *f. s.* *continued.* | |
| 302 | 146·8 |
| 303 | 147·6 |
| 308 | 143·7 |
| 309 | 148·0 |
| 310 | 145·2 |
| 311 | 147·6 |
| 339 | 148·5 |
| 357 | 159·0 |
| 363 | 151·9 |
| 369 | 210·4* |
| 374 | 160·7 |
| Mean | 147·5 |
| 1060 *f. s.* | |
| Mean | 150·5 |
| 1080 *f. s.* | |
| 184 | 153·0 |
| 185 | 130·9 |
| 187 | 145·5 |
| 189 | 148·4 |
| 191 | 153·8 |
| 192 | 141·6 |
| 196 | 158·5 |
| 261 | 152·9 |
| 262 | 149·0 |
| 263 | 152·8 |
| 264 | 149·1 |
| 266 | 152·8 |
| 267 | 152·1 |
| 270 | 150·1 |
| 277 | 144·7 |
| 279 | 145·7 |
| 281 | 150·6 |
| 282 | 145·4 |
| 290 | 157·1 |
| 292 | 151·9 |
| 300 | 141·9 |
| 301 | 149·4 |
| 302 | 146·7 |
| 303 | 148·8 |
| 304 | 150·2 |
| 308 | 146·8 |
| 309 | 150·9 |
| 310 | 149·3 |
| 311 | 150·2 |
| 312 | 158·3 |
| 320 | 171·2 |
| 1080 *f. s.* *continued.* | |
| 323 | 167·2 |
| 337 | 159·7 |
| 339 | 153·6 |
| 363 | 154·8 |
| 369 | 197·5* |
| 370 | 158·4 |
| 372 | 161·7 |
| 374 | 158·5 |
| 376 | 172·3 |
| 377 | 163·2 |
| 403 | 171·8 |
| Mean | 152·9 |
| 1100 *f. s.* | |
| Mean | 154·0 |
| 1120 *f. s.* | |
| 184 | 150·6 |
| 187 | 153·4 |
| 189 | 147·6 |
| 190 | 148·5 |
| 191 | 152·0 |
| 192 | 139·8 |
| 193 | 149·1 |
| 194 | 153·0 |
| 195 | 158·6 |
| 196 | 157·8 |
| 197 | 139·1 |
| 261 | 156·9 |
| 262 | 151·1 |
| 263 | 155·5 |
| 264 | 151·4 |
| 266 | 155·2 |
| 267 | 158·7 |
| 270 | 150·1 |
| 277 | 147·4 |
| 279 | 148·6 |
| 281 | 149·2 |
| 282 | 147·7 |
| 288 | 164·7 |
| 290 | 155·5 |
| 291 | 162·0 |
| 292 | 150·7 |
| 295 | 162·7 |
| 300 | 143·2 |
| 301 | 149·9 |
| 302 | 146·5 |
| 303 | 149·5 |

| Round | $K_v$ |
|---|---|
| 1440 *f. s.* *continued.* | |
| 370 | 139·6 |
| 371 | 136·5 |
| 372 | 138 3 |
| 373 | 135·5 |
| 374 | 140·4 |
| 375 | 133·7 |
| 376 | 134·9 |
| 377 | 144·8 |
| 378 | 140·3 |
| 379 | 134·8 |
| 380 | 147·4 |
| 381 | 138·5 |
| 382 | 142·5 |
| 383 | 158·3 |
| 385 | 141·7 |
| 386 | 150·9 |
| 387 | 141·7 |
| 388 | 135·7 |
| 389 | 136·5 |
| 390 | 147·4 |
| 392 | 137·9 |
| 394 | 137·5 |
| 395 | 139·8 |
| 396 | 139·7 |
| 398 | 113·6 |
| 399 | 138·0 |
| 400 | 134·8 |
| 401 | 137·2 |
| 402 | 139·4 |
| 403 | 137·8 |
| 404 | 137·6 |
| 405 | 145·8 |
| 406 | 139·0 |
| 408 | 138·9 |
| Mean | 139·2 |
| 1460 *f. s.* | |
| Mean | 137·8 |
| 1480 *f. s.* | |
| 179 | 132·7 |
| 180 | 137·2 |
| 181 | 131·2 |
| 182 | 133·6 |
| 183 | 130·3 |
| 204 | 137·7 |
| 206 | 133·0 |
| 241 | 128·3 |
| 242 | 141 6 |
| 243 | 137·3 |

| Round | $K_v$ |
|---|---|
| 1480 *f. s.* *continued.* | |
| 244 | 138·2 |
| 245 | 142·1 |
| 246 | 144·3 |
| 247 | 142·3 |
| 252 | 144·3 |
| 254 | 140·2 |
| 256 | 138·9 |
| 281 | 138·8 |
| 283 | 137·7 |
| 285 | 134·3 |
| 286 | 137·6 |
| 287 | 133·9 |
| 288 | 132·6 |
| 290 | 134·4 |
| 291 | 132·0 |
| 292 | 134·4 |
| 294 | 133·0 |
| 295 | 134·1 |
| 296 | 135·7 |
| 297 | 135·6 |
| 299 | 132·0 |
| 301 | 136·4 |
| 302 | 145·6 |
| 303 | 143·0 |
| 304 | 146·0 |
| 310 | 143·0 |
| 311 | 137·5 |
| 312 | 138·1 |
| 315 | 136·8 |
| 316 | 136·8 |
| 317 | 141·2 |
| 318 | 128·1 |
| 320 | 136·8 |
| 321 | 136·3 |
| 323 | 138·0 |
| 324 | 138·0 |
| 325 | 137·6 |
| 327 | 135·6 |
| 329 | 139·8 |
| 330 | 130·9 |
| 331 | 138·5 |
| 332 | 134·9 |
| 334 | 131·0 |
| 336 | 136·1 |
| 341 | 139·3 |
| 342 | 136·9 |
| 343 | 140·1 |
| 346 | 134·4 |
| 347 | 136·7 |
| 349 | 137·8 |
| 350 | 134·5 |
| 351 | 135·3 |
| 352 | 135·0 |
| 365 | 137·2 |
| 366 | 137·2 |

| Round | $K_v$ |
|---|---|
| 1480 *f. s.* *continued.* | |
| 367 | 136·0 |
| 368 | 136·8 |
| 369 | 134·2 |
| 370 | 136·2 |
| 371 | 134·4 |
| 372 | 133·8 |
| 373 | 132·7 |
| 374 | 138·6 |
| 375 | 131·2 |
| 376 | 131·4 |
| 377 | 143·2 |
| 378 | 138·1 |
| 379 | 133·2 |
| 380 | 143·4 |
| 381 | 135·6 |
| 382 | 138·6 |
| 383 | 149·2 |
| 385 | 136·8 |
| 386 | 145·8 |
| 387 | 138·7 |
| 388 | 133·1 |
| 389 | 131·4 |
| 390 | 138·2 |
| 392 | 130·9 |
| 394 | 134·7 |
| 395 | 136·7 |
| 396 | 136·7 |
| 398 | 113·6 |
| 399 | 135·3 |
| 400 | 132·1 |
| 401 | 134·5 |
| 402 | 136·1 |
| 403 | 134·7 |
| 404 | 134·5 |
| 405 | 141·9 |
| 406 | 135·8 |
| 408 | 136·2 |
| Mean | 136·4 |
| 1500 *f. s.* | |
| Mean | 134·8 |
| 1520 *f. s.* | |
| 179 | 131·7 |
| 180 | 137·3 |
| 183 | 126·7 |
| 204 | 136·6 |
| 206 | 131·6 |
| 241 | 128·8 |
| 242 | 138·3 |

| Round | $K_v$ |
|---|---|
| 1520 *f. s.* *continued.* | |
| 243 | 134·4 |
| 244 | 134·8 |
| 245 | 137·7 |
| 246 | 140·5 |
| 247 | 138·0 |
| 252 | 141·4 |
| 254 | 138·3 |
| 256 | 135·3 |
| 281 | 137·8 |
| 283 | 137·6 |
| 285 | 131·8 |
| 286 | 134·3 |
| 287 | 131·0 |
| 288 | 129·6 |
| 290 | 131·9 |
| 291 | 129·1 |
| 292 | 132·4 |
| 294 | 130·5 |
| 295 | 131·5 |
| 296 | 133·5 |
| 297 | 133·8 |
| 299 | 130·2 |
| 301 | 133·7 |
| 310 | 140·1 |
| 311 | 134·3 |
| 312 | 136·4 |
| 315 | 135·1 |
| 316 | 133·3 |
| 317 | 138·3 |
| 318 | 128·1 |
| 320 | 134·0 |
| 321 | 133·7 |
| 323 | 135·7 |
| 324 | 135·3 |
| 325 | 134·3 |
| 326 | 153·7 |
| 327 | 133·5 |
| 329 | 134·7 |
| 330 | 128·9 |
| 331 | 137·0 |
| 332 | 134·9 |
| 334 | 127·5 |
| 336 | 133·0 |
| 341 | 136·3 |
| 342 | 135·0 |
| 343 | 139·8 |
| 346 | 130·5 |
| 347 | 133·3 |
| 349 | 133·2 |
| 350 | 131·5 |
| 351 | 132·3 |
| 352 | 133·2 |
| 365 | 134·4 |
| 366 | 134·0 |
| 367 | 133·0 |

| Round | $K_v$ |
|---|---|
| 1520 *f. s.* *continued.* | |
| 368 | 134·7 |
| 369 | 133·1 |
| 370 | 132·9 |
| 371 | 132·4 |
| 372 | 129·0 |
| 373 | 130·5 |
| 374 | 136·8 |
| 375 | 128·8 |
| 376 | 128·0 |
| 378 | 135·9 |
| 379 | 131·6 |
| 380 | 139·5 |
| 381 | 132·7 |
| 382 | 134·7 |
| 383 | 140·0 |
| 385 | 131·9 |
| 386 | 140·0 |
| 387 | 135·8 |
| 388 | 130·8 |
| 389 | 126·4 |
| 390 | 128·9 |
| 392 | 124·1 |
| 394 | 132·1 |
| 395 | 133·7 |
| 396 | 133·9 |
| 398 | 113·6 |
| 399 | 132·6 |
| 400 | 129·6 |
| 401 | 131·9 |
| 402 | 132·9 |
| 403 | 131·7 |
| 404 | 131·6 |
| 405 | 138·0 |
| 406 | 132·7 |
| 408 | 133·5 |
| 409 | 136·9 |
| Mean | 133·6 |
| 1540 *f. s.* | |
| Mean | 132·4 |
| 1560 *f. s.* | |
| 204 | 135·6 |
| 205 | 123·7 |
| 206 | 130·3 |
| 241 | 129·3 |
| 242 | 135·6 |
| 243 | 131·7 |
| 244 | 131·6 |
| 245 | 133·9 |

| Round | $K_v$ |
|---|---|
| 1560 *f. s.* *continued.* | |
| 246 | 137·1 |
| 247 | 133·5 |
| 248 | 134·6 |
| 249 | 127·0 |
| 252 | 138·4 |
| 254 | 136·6 |
| 256 | 132·6 |
| 257 | 140·3 |
| 258 | 137·3 |
| 260 | 144·8 |
| 285 | 129·4 |
| 286 | 131·2 |
| 287 | 128·3 |
| 288 | 126·6 |
| 290 | 129·4 |
| 291 | 126·4 |
| 292 | 130·3 |
| 293 | 123·2 |
| 294 | 128·1 |
| 295 | 128·9 |
| 296 | 131·3 |
| 297 | 132·0 |
| 299 | 128·4 |
| 301 | 131·0 |
| 310 | 136·6 |
| 311 | 131·0 |
| 312 | 134·8 |
| 315 | 133·4 |
| 316 | 130·1 |
| 317 | 135·3 |
| 320 | 131·4 |
| 321 | 131·3 |
| 322 | 135·9 |
| 323 | 133·5 |
| 324 | 132·8 |
| 325 | 131·2 |
| 326 | 146·1 |
| 327 | 131·6 |
| 329 | 129·6 |
| 330 | 127·1 |
| 331 | 135·3 |
| 332 | 134·9 |
| 334 | 124·2 |
| 336 | 129·9 |
| 341 | 133·4 |
| 342 | 133·3 |
| 343 | 139·7 |
| 346 | 126·7 |
| 347 | 129·9 |
| 349 | 128·7 |
| 350 | 128·6 |
| 251 | 129·5 |
| 352 | 131·5 |
| 365 | 131·7 |
| 366 | 130·7 |

| Round | $K_v$ |
|---|---|
| 1560 *f. s.* *continued.* | |
| 373 | 128·3 |
| 374 | 135·1 |
| 375 | 126·4 |
| 378 | 133·7 |
| 379 | 130·3 |
| 380 | 135·7 |
| 381 | 129·7 |
| 382 | 130·7 |
| 383 | 130·9 |
| 385 | 127·3 |
| 386 | 133·4 |
| 387 | 132·9 |
| 394 | 129·5 |
| 395 | 130·7 |
| 396 | 131·1 |
| 398 | 113·6 |
| 399 | 129·9 |
| 400 | 127·2 |
| 401 | 129·4 |
| 402 | 129·8 |
| 403 | 128·8 |
| 404 | 128·7 |
| 405 | 134·3 |
| 406 | 129·6 |
| 408 | 130·9 |
| 409 | 129·7 |
| 410 | 126·9 |
| Mean | 131·4 |
| 1580 *f. s.* | |
| Mean | 129·8 |
| 1600 *f. s.* | |
| 204 | 134·1 |
| 205 | 122·6 |
| 206 | 129·3 |
| 241 | 128·9 |
| 242 | 132·5 |
| 243 | 129·0 |
| 244 | 128·4 |
| 245 | 130·2 |
| 246 | 133·7 |
| 247 | 129·2 |
| 248 | 132·4 |
| 249 | 125·5 |
| 251 | 118·1 |
| 252 | 135·5 |
| 253 | 123·3 |
| 254 | 135·3 |
| 256 | 131·0 |

| Round | $K_v$ |
|---|---|
| 1600 *f. s.* *continued.* | |
| 257 | 135·0 |
| 258 | 132·7 |
| 259 | 121·8 |
| 260 | 140·8 |
| 285 | 127·0 |
| 286 | 128·1 |
| 287 | 125·6 |
| 288 | 123·8 |
| 290 | 126·9 |
| 291 | 123·7 |
| 292 | 128·2 |
| 293 | 122·7 |
| 294 | 125·8 |
| 295 | 126·4 |
| 296 | 129·1 |
| 297 | 130·3 |
| 299 | 126·7 |
| 301 | 128·1 |
| 310 | 133·2 |
| 311 | 127·7 |
| 312 | 133·2 |
| 315 | 131·7 |
| 316 | 127·3 |
| 317 | 132·5 |
| 320 | 128·8 |
| 321 | 128·9 |
| 322 | 131·8 |
| 323 | 131·3 |
| 324 | 130·5 |
| 325 | 128·2 |
| 326 | 138·7 |
| 327 | 129·8 |
| 329 | 124·7 |
| 330 | 125·4 |
| 341 | 130·5 |
| 346 | 122·9 |
| 347 | 126·6 |
| 349 | 124·3 |
| 350 | 125·8 |
| 351 | 126·9 |
| 352 | 129·8 |
| 365 | 129·1 |
| 366 | 127·4 |
| 373 | 125·9 |
| 375 | 124·1 |
| 378 | 131·6 |
| 379 | 129·1 |
| 380 | 131·9 |
| 381 | 126·9 |
| 382 | 126·8 |
| 383 | 121·3 |
| 385 | 122·9 |
| 386 | 126·7 |
| 387 | 130·2 |
| 394 | 127·0 |

| Round | $K_v$ |
|---|---|
| 1600 *f. s.* *continued.* | |
| 395 | 127·8 |
| 396 | 128·3 |
| 398 | 113·6 |
| 399 | 127·4 |
| 400 | 124·8 |
| 401 | 127·0 |
| 402 | 126·8 |
| 403 | 126·0 |
| 404 | 126·0 |
| 405 | 130·6 |
| 406 | 126·7 |
| 408 | 128·4 |
| 409 | 124·0 |
| 410 | 124·9 |
| Mean | 128·1 |
| 1620 *f. s.* | |
| Mean | 126·7 |
| 1640 *f. s.* | |
| 204 | 131·9 |
| 205 | 121·6 |
| 206 | 128·6 |
| 241 | 129·4 |
| 242 | 129·5 |
| 243 | 126·5 |
| 244 | 125·1 |
| 245 | 126·6 |
| 246 | 130·4 |
| 247 | 125·0 |
| 248 | 130·0 |
| 249 | 124·1 |
| 251 | 117·9 |
| 252 | 132·6 |
| 253 | 122·6 |
| 254 | 134·4 |
| 255 | 115·4 |
| 256 | 130·1 |
| 257 | 130·1 |
| 258 | 127·9 |
| 259 | 118·9 |
| 260 | 135·7 |
| 285 | 124·7 |
| 286 | 125·1 |
| 287 | 123·1 |
| 288 | 121·1 |
| 290 | 124·6 |
| 291 | 121·1 |
| 292 | 126·1 |
| 293 | 122·3 |

| Round | $K_v$ |
|---|---|
| 1640 *f. s.* *continued.* | |
| 294 | 123·6 |
| 295 | 124·0 |
| 296 | 127·0 |
| 297 | 128·7 |
| 299 | 125·1 |
| 301 | 125·0 |
| 310 | 129·5 |
| 311 | 124·4 |
| 312 | 131·6 |
| 315 | 130·1 |
| 316 | 124·7 |
| 317 | 129·7 |
| 320 | 126·4 |
| 321 | 126·6 |
| 322 | 127·9 |
| 323 | 129·2 |
| 324 | 128·2 |
| 325 | 125·2 |
| 326 | 131·3 |
| 327 | 127·7 |
| 329 | 119·8 |
| 330 | 123·6 |
| 341 | 127·8 |
| 346 | 119·1 |
| 347 | 123·4 |
| 349 | 120·1 |
| 350 | 123·0 |
| 351 | 124·2 |
| 352 | 128·2 |
| 366 | 124·0 |
| 373 | 123·7 |
| 375 | 122·0 |
| 379 | 128·0 |
| 380 | 128·3 |
| 381 | 124·1 |
| 385 | 118·8 |
| 386 | 119·5 |
| 387 | 127·5 |
| 394 | 124·5 |
| 395 | 125·0 |
| 396 | 125·7 |
| 398 | 113·6 |
| 399 | 124·9 |
| 400 | 122·5 |
| 401 | 124·6 |
| 402 | 123·9 |
| 403 | 123·3 |
| 404 | 123·4 |
| 405 | 127·1 |
| 406 | 123·9 |
| 408 | 125·9 |
| 409 | 119·7 |
| 410 | 123·0 |
| Mean | 125·4 |

| Round | $K_v$ |
|---|---|
| 1660 *f. s.* | |
| Mean | 124·0 |
| 1680 *f. s.* | |
| 205 | 120·8 |
| 241 | 128·8 |
| 245 | 122·1 |
| 247 | 121·1 |
| 248 | 127·3 |
| 249 | 122·5 |
| 251 | 117·9 |
| 253 | 121·5 |
| 254 | 133·9 |
| 255 | 115·9 |
| 257 | 125·2 |
| 258 | 122·9 |
| 259 | 116·2 |
| 260 | 129·5 |
| 285 | 122·4 |
| 286 | 122·2 |
| 287 | 120·6 |
| 288 | 118·5 |
| 290 | 122·4 |
| 291 | 118·6 |
| 292 | 124·0 |
| 293 | 121·9 |
| 294 | 121·6 |
| 295 | 121·6 |
| 296 | 125·1 |
| 297 | 127·1 |
| 299 | 123·5 |
| 301 | 121·8 |
| 310 | 125·4 |
| 311 | 121·2 |
| 312 | 130·1 |
| 315 | 128·5 |
| 316 | 122·5 |
| 317 | 127·0 |
| 320 | 124·0 |
| 321 | 124·4 |
| 322 | 123·9 |
| 323 | 127·1 |
| 324 | 125·8 |
| 325 | 122·2 |
| 326 | 123·8 |
| 327 | 125·6 |
| 329 | 115·3 |
| 330 | 121·9 |
| 341 | 125·2 |
| 346 | 115·4 |
| 347 | 120·4 |
| 349 | 115·9 |
| 350 | 120·3 |
| 352 | 126·6 |
| 373 | 121·4 |

| Round | $K_v$ |
|---|---|
| 1680 *f. s.* *continued.* | |
| 379 | 127·0 |
| 380 | 124·6 |
| 381 | 121·4 |
| 385 | 114·9 |
| 394 | 122·1 |
| 395 | 122·3 |
| 396 | 123·1 |
| 398 | 113·6 |
| 399 | 122·5 |
| 400 | 120·3 |
| 401 | 122·2 |
| 402 | 121·1 |
| 403 | 120·6 |
| 404 | 120·9 |
| 405 | 123·7 |
| 406 | 121·1 |
| 408 | 123·6 |
| 409 | 116·9 |
| 410 | 121·1 |
| 411 | 119·0 |
| Mean | 122·4 |
| 1700 *f. s.* | |
| Mean | 121·1 |
| 1720 *f. s.* | |
| 248 | 124·4 |
| 249 | 121·2 |
| 251 | 117·9 |
| 253 | 120·4 |
| 255 | 116·3 |
| 257 | 119·7 |
| 258 | 118·0 |
| 259 | 114·5 |
| 260 | 122·8 |
| 284 | 105·2 |
| 285 | 120·3 |
| 286 | 119·4 |
| 287 | 118·2 |
| 288 | 115·9 |
| 291 | 116·1 |
| 292 | 121·8 |
| 293 | 121·5 |
| 294 | 119·6 |
| 295 | 119·3 |
| 296 | 123·2 |
| 297 | 125·6 |
| 299 | 122·0 |
| 301 | 118·5 |
| 310 | 121·3 |

| Round | $K_v$ |
|---|---|
| 1720 *f. s.* *continued.* | |
| 311 | 118·0 |
| 315 | 126·8 |
| 316 | 120·7 |
| 317 | 124·4 |
| 320 | 121·7 |
| 321 | 122·2 |
| 322 | 120·1 |
| 323 | 125·1 |
| 324 | 123·7 |
| 325 | 119·3 |
| 326 | 116·2 |
| 327 | 123·4 |
| 330 | 120·5 |
| 341 | 122·6 |
| 373 | 119·0 |
| 379 | 126·3 |
| 380 | 121·0 |
| 381 | 118·8 |
| 394 | 119·7 |
| 395 | 119·6 |
| 396 | 120·6 |
| 398 | 113·6 |
| 399 | 120·2 |
| 400 | 118·2 |
| 401 | 120·0 |
| 402 | 118·3 |
| 403 | 118·1 |
| 404 | 118·4 |
| 405 | 120·3 |
| 406 | 118·3 |
| 408 | 121·3 |
| 409 | 114·7 |
| 410 | 119·4 |
| 411 | 116·9 |
| Mean | 119·8 |
| 1740 *f. s.* | |
| Mean | 118·5 |
| 1760 *f. s.* | |
| 248 | 121·3 |
| 249 | 120·0 |
| 251 | 117·9 |
| 253 | 118·8 |
| 255 | 116·4 |
| 257 | 114·2 |
| 258 | 112·9 |
| 259 | 113·0 |
| 260 | 115·1 |
| 284 | 105·3 |
| 1760 *f. s.* *continued.* | |
| 285 | 118·2 |
| 286 | 116·6 |
| 287 | 115·9 |
| 288 | 113·4 |
| 291 | 113·7 |
| 293 | 121·1 |
| 294 | 117·6 |
| 299 | 120·5 |
| 301 | 115·0 |
| 310 | 116·8 |
| 311 | 115·2 |
| 315 | 125·3 |
| 316 | 119·1 |
| 317 | 122·0 |
| 320 | 119·5 |
| 321 | 120·1 |
| 322 | 116·2 |
| 323 | 123·2 |
| 324 | 121·6 |
| 325 | 116·5 |
| 380 | 117·4 |
| 381 | 116·3 |
| 394 | 117·5 |
| 395 | 116·9 |
| 396 | 118·1 |
| 398 | 113·6 |
| 399 | 118·0 |
| 400 | 116·1 |
| 401 | 117·7 |
| 402 | 115·5 |
| 403 | 115·6 |
| 404 | 116·0 |
| 405 | 116·9 |
| 406 | 115·6 |
| 408 | 119·2 |
| 409 | 113·0 |
| 410 | 117·6 |
| 411 | 114·9 |
| Mean | 117·0 |
| 1780 *f. s.* | |
| Mean | 115·2 |
| 1800 *f. s.* | |
| 248 | 117·8 |
| 249 | 118·8 |
| 251 | 117·9 |
| 253 | 117·0 |
| 255 | 116·4 |
| 257 | 108·0 |
| 1800 *f. s.* *continued.* | |
| 258 | 107·9 |
| 259 | 112·7 |
| 260 | 106·8 |
| 284 | 105·4 |
| 285 | 116·0 |
| 286 | 114·1 |
| 287 | 113·6 |
| 288 | 111·0 |
| 291 | 111·3 |
| 293 | 120·6 |
| 294 | 115·8 |
| 301 | 111·6 |
| 310 | 111·9 |
| 311 | 112·5 |
| 315 | 123·8 |
| 317 | 119·6 |
| 320 | 117·3 |
| 321 | 118·1 |
| 322 | 112·4 |
| 323 | 121·3 |
| 324 | 119·6 |
| 325 | 113·7 |
| 380 | 113·8 |
| 381 | 114·0 |
| 394 | 115·3 |
| 395 | 114·3 |
| 396 | 115·6 |
| 398 | 113·5 |
| 399 | 115·7 |
| 400 | 114·1 |
| 401 | 115·6 |
| 402 | 112·9 |
| 403 | 113·2 |
| 404 | 113·6 |
| 405 | 113·7 |
| 406 | 112·9 |
| 407 | 115·4 |
| 408 | 117·2 |
| 409 | 111·7 |
| 410 | 115·8 |
| 411 | 112·9 |
| Mean | 114·6 |
| 1820 *f. s.* | |
| Mean | 113·2 |
| 1840 *f. s.* | |
| 248 | 114·3 |
| 249 | 117·7 |
| 251 | 117·7 |
| 1840 *f. s.* *continued.* | |
| 253 | 114·8 |
| 255 | 116·1 |
| 257 | 100·9 |
| 258 | 103·0 |
| 259 | 112·7 |
| 260 | 97·6 |
| 284 | 105·4 |
| 285 | 114·1 |
| 286 | 111·5 |
| 287 | 111·5 |
| 288 | 108·6 |
| 291 | 109·1 |
| 294 | 113·9 |
| 310 | 107·0 |
| 311 | 109·8 |
| 320 | 115·2 |
| 321 | 116·1 |
| 322 | 108·7 |
| 323 | 119·4 |
| 324 | 117·6 |
| 325 | 110·9 |
| 380 | 110·4 |
| 394 | 113·1 |
| 395 | 111·8 |
| 396 | 113·3 |
| 398 | 113·5 |
| 399 | 113·5 |
| 400 | 112·2 |
| 401 | 113·4 |
| 402 | 110·3 |
| 404 | 111·3 |
| 405 | 110·5 |
| 406 | 110·3 |
| 407 | 111·3 |
| 408 | 115·2 |
| 409 | 110·5 |
| 410 | 114·0 |
| 411 | 110·9 |
| Mean | 111·7 |
| 1860 *f. s.* | |
| Mean | 111·4 |
| 1880 *f. s.* | |
| 248 | 110·7 |
| 249 | 116·6 |
| 251 | 117·5 |
| 253 | 112·7 |
| 255 | 115·9 |
| 284 | 105·3 |
| 1880 *f. s.* *continued.* | |
| 285 | 112·2 |
| 286 | 108·8 |
| 287 | 109·4 |
| 288 | 106·2 |
| 310 | 101·6 |
| 311 | 108·0 |
| 323 | 117·6 |
| 394 | 111·0 |
| 395 | 109·3 |
| 396 | 110·9 |
| 397 | 107·9 |
| 398 | 113·4 |
| 399 | 111·4 |
| 400 | 110·2 |
| 401 | 111 4 |
| 404 | 109·0 |
| 406 | 107·8 |
| 407 | 107·3 |
| 409 | 109 6 |
| 410 | 112·3 |
| 411 | 109·0 |
| Mean | 110·5 |
| 1900 *f. s.* | |
| Mean | 108·9 |
| 1920 *f. s.* | |
| 248 | 107·0 |
| 251 | 117·5 |
| 284 | 105·3 |
| 285 | 110·3 |
| 286 | 106·3 |
| 287 | 107·3 |
| 310 | 96·0 |
| 311 | 106·1 |
| 394 | 108·9 |
| 395 | 106·9 |
| 396 | 108·7 |
| 397 | 105·9 |
| 398 | 113·3 |
| 399 | 109·3 |
| 400 | 108·5 |
| 401 | 109·4 |
| 407 | 103·2 |
| 409 | 108·7 |
| 410 | 110·7 |
| 411 | 107·2 |
| Mean | 107·8 |
| 1940 *f. s.* | |
| Mean | 106·8 |
| 1960 *f. s.* | |
| 248 | 103·1 |
| 284 | 105·2 |
| 285 | 108·4 |
| 286 | 103·8 |
| 287 | 105·3 |
| 310 | 90·3 |
| 311 | 104·3 |
| 394 | 106·8 |
| 395 | 104·5 |
| 396 | 106·4 |
| 397 | 104·0 |
| 398 | 113·2 |
| 399 | 107·2 |
| 400 | 106·7 |
| 401 | 107·4 |
| 407 | 99·2 |
| 409 | 107·6 |
| 410 | 109·0 |
| 411 | 105·5 |
| Mean | 105·2 |
| 1980 *f. s.* | |
| Mean | 105·8 |
| 2000 *f. s.* | |
| 284 | 105·2 |
| 286 | 101·4 |
| 287 | 103·3 |
| 394 | 104·8 |
| 395 | 102·1 |
| 396 | 104·2 |
| 397 | 102·1 |
| 398 | 113·2 |
| 399 | 105·2 |
| 400 | 105·0 |
| 401 | 105·5 |
| 409 | 106·3 |
| 410 | 107·3 |
| 411 | 103·9 |
| Mean | 105·0 |
| 2020 *f. s.* | |
| Mean | 104·2 |

| Round | $K_v$ |
|---|---|
| 2040 *f. s.* | |
| 286 | 98·9 |
| 394 | 102·8 |
| 395 | 99·7 |
| 396 | 102·0 |
| 397 | 100·2 |
| 398 | 113·1 |
| 399 | 103·2 |
| 400 | 103·3 |
| 401 | 103·7 |
| 409 | 104·8 |
| 410 | 105·6 |
| 411 | 102·3 |
| Mean | 103·3 |
| 2060 *f. s.* | |
| Mean | 102·9 |

| Round | $K_v$ |
|---|---|
| 2080 *f. s.* | |
| 394 | 100·8 |
| 395 | 97·4 |
| 396 | 99·8 |
| 397 | 98·5 |
| 398 | 113·0 |
| 399 | 101·3 |
| 400 | 101·6 |
| 401 | 101·8 |
| 409 | 103·1 |
| 410 | 104·0 |
| 411 | 100·8 |
| Mean | 102·0 |
| 2100 *f. s.* | |
| Mean | 100·0 |

| Round | $K_v$ |
|---|---|
| 2120 *f. s.* | |
| 394 | 99·0 |
| 395 | 95·1 |
| 396 | 97·8 |
| 397 | 96·7 |
| 398 | 113·0* |
| 399 | 99·4 |
| 400 | 100·1 |
| 401 | 100·0 |
| 410 | 102·4 |
| Mean | 98·8 |
| 2140 *f. s.* | |
| Mean | 97·9 |

| Round | $K_v$ |
|---|---|
| 2160 *f. s.* | |
| 394 | 97·1 |
| 395 | 92·8 |
| 396 | 95·7 |
| 397 | 94·9 |
| 398 | 112·9* |
| 399 | 97·5 |
| 400 | 98·6 |
| 401 | 98·2 |
| Mean | 96·4 |
| 2180 *f. s.* | |
| Mean | 95·5 |

| Round | $K_v$ |
|---|---|
| 2200 *f. s.* | |
| 395 | 90·7 |
| 396 | 93·6 |
| 397 | 93·2 |
| 398 | 112·8* |
| 399 | 95·7 |
| 401 | 96·4 |
| Mean | 93·9 |
| 2220 *f. s.* | |
| Mean | 93·0 |
| 2240 *f. s.* | |
| 395 | 88·5 |
| 396 | 91·6 |
| 397 | 91·4 |

| Round | $K_v$ |
|---|---|
| 2240 *f. s.* *continued.* | |
| 398 | 112·7* |
| 399 | 93·9 |
| 401 | 94·7 |
| Mean | 92·0 |
| 2260 *f. s.* | |
| Mean | 91·3 |
| 2280 *f. s.* | |
| 396 | 89·7 |
| 398 | 112·6* |
| 401 | 93·0 |
| Mean | 91·4 |

74. Density of the Air when the following Rounds were fired.

| No. of Rounds | Density | No. of Rounds | Density | No. of Rounds | Density |
|---|---|---|---|---|---|
| 1— 15 | 1·002 | 225—240 | 0·989 | 431—438 | 1·025 |
| 16— 41 | 1·011 | 241—260 | 0·986 | 439—444 | 1·039 |
| 42— 60 | 1·025 | 261—287 | 1·005 | 445—448 | 1·031 |
| 61— 68 | 1·045 | 288—312 | 1·015 | 449—452 | 1·053 |
| 69— 84 | 1·045 | 313—325 | 1·005 | 453—460 | 1·054 |
| 85— 89 | 1·028 | 326—340 | 1·032 | 461 | 1·030 |
| 90—102 | 1·020 | 341—352 | 1·037 | 462 | 1·034 |
| 103—117 | 1·027 | 353—364 | 1·016 | 463 | 1·042 |
| 118—138 | 1·037 | 365—379 | 1·030 | 464—466 | 1·051 |
| 139—147 | 1·007 | 380—391 | 1·002 | 467—477 | 1·039 |
| 148—178 | 1·001 | 392—411 | 1·026 | 478—482 | 1·014 |
| 179—187 | 1·034 | 412—414 | 1·011 | 483—488 | 1·046 |
| 188—206 | 1·011 | 415—423 | 1·008 | 489—499 | 1·037 |
| 207—224 | 0·986 | 424—430 | 1·020 | 500—502 | 1·024 |

## 75. Corrected mean values of $K_v$ for Spherical Projectiles. ($w = 534{\cdot}22$ grains).

| $v$ *f. s.* | Experimental values of $K_v$ | Correction | Corrected values of $K_v$ | $v$ *f. s.* | Experimental values of $K_v$ | Correction | Corrected values of $K_v$ |
|---|---|---|---|---|---|---|---|
| 720 | 119·2 | | | 1520 | 133·6 | +0·3 | 133·9 |
| 740 | 113·2 | | | 1540 | 132·4 | +0·1 | 132·5 |
| 760 | 106·5 | | | 1560 | 131·4 | −0·3 | 131·1 |
| 780 | 106·8 | | | 1580 | 129·8 | −0·1 | 129·7 |
| 800 | 118·2 | | | 1600 | 128·1 | +0·2 | 128·3 |
| 820 | 128·2 | | | 1620 | 126·7 | +0·2 | 126·9 |
| 840 | 133·9 | +6·9 | 140·8 | 1640 | 125·4 | +0·1 | 125·5 |
| 860 | 136·4 | +4·4 | 140·8 | 1660 | 124·0 | +0·1 | 124·1 |
| 880 | 140·0 | +0·8 | 140·8 | 1680 | 122·4 | +0·3 | 122·7 |
| 900 | 141·7 | −0·9 | 140·8 | 1700 | 121·1 | +0·2 | 121·3 |
| 920 | 141·1 | −0·3 | 140·8 | 1720 | 119·8 | +0·1 | 119·9 |
| 940 | 141·0 | −0·2 | 140·8 | 1740 | 118·5 | 0 | 118·5 |
| 960 | 140·7 | +0·1 | 140·8 | 1760 | 117·0 | +0·1 | 117·1 |
| 980 | 141·7 | −0·5 | 141·2 | 1780 | 115·2 | +0·5 | 115·7 |
| 1000 | 142·9 | −0·9 | 142·0 | 1800 | 114·6 | −0·2 | 114·4 |
| 1020 | 144·0 | 0 | 144·0 | 1820 | 113·2 | −0·1 | 113·1 |
| 1040 | 147·5 | 0 | 147·5 | 1840 | 111·7 | +0·2 | 111·9 |
| 1060 | 150·5 | 0 | 150·5 | 1860 | 111·4 | −0·6 | 110·8 |
| 1080 | 152·9 | −0·3 | 152·6 | 1880 | 110·5 | −0·7 | 109·8 |
| 1100 | 154·0 | +0·1 | 154·1 | 1900 | 108·9 | 0 | 108·9 |
| 1120 | 155·4 | −0·3 | 155·1 | 1920 | 107·8 | +0·3 | 108·1 |
| 1140 | 155·3 | +0·4 | 155·7 | 1940 | 106·8 | +0·5 | 107·3 |
| 1160 | 156·4 | −0·4 | 156·0 | 1960 | 105·2 | +1·3 | 106·5 |
| 1180 | 156·2 | −0·2 | 156·0 | 1980 | 105·8 | −0·1 | 105·7 |
| 1200 | 154·9 | +0·6 | 155·5 | 2000 | 105·0 | −0·1 | 104·9 |
| 1220 | 154·2 | +0·4 | 154·6 | 2020 | 104·2 | −0·1 | 104·1 |
| 1240 | 152·7 | +0·7 | 153·4 | 2040 | 103·3 | −0·1 | 103·2 |
| 1260 | 151·4 | +0·6 | 152·0 | 2060 | 102·9 | −0·7 | 102·2 |
| 1280 | 150·1 | +0·4 | 150·5 | 2080 | 102·0 | −0·9 | 101·1 |
| 1300 | 148·6 | +0·1 | 148·7 | 2100 | 100·0 | −0·1 | 99·9 |
| 1320 | 147·6 | −0·4 | 147·2 | 2120 | 98·8 | −0·1 | 98·7 |
| 1340 | 146·8 | −0·8 | 146·0 | 2140 | 97·9 | −0·3 | 97·6 |
| 1360 | 145·2 | −0·5 | 144·7 | 2160 | 96·4 | +0·1 | 96·5 |
| 1380 | 143·5 | −0·1 | 143·4 | 2180 | 95·5 | −0·1 | 95·4 |
| 1400 | 142·3 | −0·2 | 142·1 | 2200 | 93·9 | +0·5 | 94·4 |
| 1420 | 140·7 | +0·1 | 140·8 | 2220 | 93·0 | +0·4 | 93·4 |
| 1440 | 139·2 | +0·3 | 139·5 | 2240 | 92·0 | +0·4 | 92·4 |
| 1460 | 137·8 | +0·3 | 138·1 | 2260 | 91·3 | +0·1 | 91·4 |
| 1480 | 136·4 | +0·3 | 136·7 | 2280 | 91·4 | −1·0 | 90·4 |
| 1500 | 134·8 | +0·5 | 135·3 | | | | |

76. Reports dated July 23, 1868, July 8, 1879, and Aug. 31, 1880.

| Round | $K_v$ |
|---|---|
| **430 *f. s.*** | |
| 455 | 222·2* |
| 457 | 126·1 |
| 459 | 135·1 |
| Mean | 130·6 |
| **435 *f. s.*** | |
| Mean | 133·6 |
| **440 *f. s.*** | |
| 455 | 199·7* |
| 457 | 126·1 |
| 459 | 141·1 |
| Mean | 133·6 |
| **465 *f. s.*** | |
| Mean | 129·9 |
| **470 *f. s.*** | |
| 454 | 171·2* |
| 456 | 108·1 |
| 458 | 153·1 |
| Mean | 130·6 |
| **475 *f. s.*** | |
| Mean | 120·1 |
| **530 *f. s.*** | |
| 442 | 117·3 |
| 453 | 123·1 |
| Mean | 120·2 |
| **535 *f. s.*** | |
| Mean | 118·8 |
| **540 *f. s.*** | |
| 439 | 107·7 |
| 442 | 116·0 |
| 452 | 114·2 |
| 453 | 112·6 |
| Mean | 112·6 |
| **545 *f. s.*** | |
| Mean | 107·2 |
| **550 *f. s.*** | |
| 439 | 100·4 |
| 441 | 89·0 |
| 442 | 116·6 |
| 452 | 105·2 |
| Mean | 102·8 |
| **555 *f. s.*** | |
| Mean | 101·5 |
| **560 *f. s.*** | |
| 438 | 87·4 |
| 439 | 94·3 |
| 440 | 104·8 |
| 441 | 89·4 |
| 442 | 114·8 |
| Mean | 98·1 |
| **565 *f. s.*** | |
| Mean | 99·5 |
| **570 *f. s.*** | |
| 438 | 105·9 |
| 439 | 94·3 |
| 440 | 102·1 |
| 441 | 91·0 |
| 442 | 116·0 |
| 448 | 93·7 |
| Mean | 100·5 |
| **575 *f. s.*** | |
| Mean | 98·6 |
| **580 *f. s.*** | |
| 438 | 123·2 |
| 439 | 93·0 |
| 440 | 99·0 |
| 441 | 93·3 |
| 448 | 90·0 |
| 450 | 160·3* |
| Mean | 99·7 |
| **585 *f. s.*** | |
| Mean | 102·6 |
| **590 *f. s.*** | |
| 438 | 139·5 |
| 440 | 88·6 |
| 441 | 94·3 |
| 448 | 85·7 |
| 449 | 177·3* |
| 450 | 169·8* |
| 451 | 96·2 |
| Mean | 100·9 |
| **595 *f. s.*** | |
| Mean | 112·9 |
| **600 *f. s.*** | |
| 438 | 153·9* |
| 448 | 81·0 |
| 449 | 153·3* |
| 450 | 105·2 |
| 451 | 115·7 |
| Mean | 100·6 |
| **605 *f. s.*** | |
| Mean | 113·2 |
| **650 *f. s.*** | |
| 436 | 92·6 |
| 437 | 98·4 |
| Mean | 95·5 |
| **655 *f. s.*** | |
| Mean | 96·5 |
| **660 *f. s.*** | |
| 433 | 94·2 |
| 436 | 98·4 |
| 437 | 100·4 |
| Mean | 97·7 |
| **665 *f. s.*** | |
| Mean | 99·6 |
| **670 *f. s.*** | |
| 433 | 94·2 |
| 435 | 101·9 |
| 436 | 103·0 |
| 437 | 100·4 |
| Mean | 99·9 |
| **675 *f. s.*** | |
| Mean | 100·1 |
| **680 *f. s.*** | |
| 426 | 120·5 |
| 433 | 96·0 |
| 434 | 87·4 |
| 435 | 101·9 |
| 436 | 98·8 |
| 437 | 101·7 |
| 447 | 83·8 |
| Mean | 98·6 |
| **685 *f. s.*** | |
| Mean | 97·5 |
| **690 *f. s.*** | |
| 426 | 108·8 |
| 433 | 96·8 |
| 434 | 88·7 |
| 435 | 103·2 |
| 436 | 93·9 |
| 437 | 101·7 |
| 447 | 81·4 |
| Mean | 96·4 |
| **695 *f. s.*** | |
| Mean | 90·7 |
| **700 *f. s.*** | |
| 426 | 94·3 |
| 432 | 72·7 |
| 433 | 96·0 |
| 434 | 89·3 |
| 435 | 103·2 |
| 445 | 72·5 |
| 447 | 79·2 |
| Mean | 86·7 |
| **705 *f. s.*** | |
| Mean | 84·9 |
| **710 *f. s.*** | |
| 426 | 80·9 |
| 432 | 61·3 |
| 434 | 92·3 |
| 435 | 103·2 |
| 443 | 80·5 |
| 445 | 71·9 |
| 447 | 77·7 |
| Mean | 81·1 |
| **715 *f. s.*** | |
| Mean | 80·2 |
| **720 *f. s.*** | |
| 424 | 75·0 |
| 426 | 77·6 |
| 434 | 94·9 |
| 435 | 103·6 |
| 443 | 78·9 |
| 445 | 71·9 |
| 447 | 76·4 |
| Mean | 82·6 |
| **725 *f. s.*** | |
| Mean | 81·0 |
| **730 *f. s.*** | |
| 424 | 74·1 |
| 426 | 77·3 |
| 434 | 96·5 |
| 435 | 105·8 |
| 443 | 78·3 |
| 444 | 70·9 |
| 445 | 69·4 |
| 447 | 76·4 |
| Mean | 81·1 |
| **735 *f. s.*** | |
| Mean | 77·2 |
| **740 *f. s.*** | |
| 424 | 72·3 |
| 425 | 100·4 |
| 428 | 70·8 |
| 443 | 78·3 |
| 444 | 71·9 |
| 446 | 70·3 |
| Mean | 77·3 |

| Round | $K_v$ |
|---|---|
| 745 *f. s.* | |
| Mean | 78·0 |
| 750 *f. s.* | |
| 55 | 89·7 |
| 57 | 90·0 |
| 138 | 95·3 |
| 424 | 82·6 |
| 425 | 94·2 |
| 428 | 70·8 |
| 443 | 83·3 |
| 444 | 70·9 |
| 446 | 70·3 |
| Mean | 83·0 |
| 755 *f. s.* | |
| Mean | 83·2 |
| 760 *f. s.* | |
| 55 | 89·7 |
| 56 | 86·4 |
| 57 | 85·4 |
| 60 | 95·2 |
| 138 | 95·3 |
| 424 | 82·9 |
| 425 | 87·2 |
| 428 | 70·8 |
| 443 | 85·8 |
| 444 | 70·9 |
| 446 | 69·0 |
| Mean | 83·5 |
| 765 *f. s.* | |
| Mean | 85·5 |
| 770 *f. s.* | |
| 55 | 90·1 |
| 56 | 84·5 |
| 57 | 82·0 |
| 59 | 102·0 |
| 60 | 91·7 |
| 137 | 95·5 |
| 138 | 95·3 |
| 425 | 80·1 |
| 770 *f. s.* *continued.* | |
| 428 | 69·4 |
| 444 | 71·2 |
| 446 | 68·7 |
| Mean | 84·6 |
| 775 *f. s.* | |
| Mean | 81·9 |
| 780 *f. s.* | |
| 57 | 78·5 |
| 59 | 98·9 |
| 60 | 87·2 |
| 135 | 91·7 |
| 137 | 92·1 |
| 425 | 72·1 |
| 427 | 68·7 |
| 428 | 66·1 |
| 446 | 67·8 |
| Mean | 80·3 |
| 785 *f. s.* | |
| Mean | 75·6 |
| 790 *f. s.* | |
| 137 | 88·2 |
| 425 | 62·2 |
| 427 | 64·5 |
| 428 | 63·9 |
| Mean | 69·7 |
| 795 *f. s.* | |
| Mean | 74·6 |
| 800 *f. s.* | |
| 427 | 61·4 |
| 430 | 62·7 |
| Mean | 62·1 |
| 805 *f. s.* | |
| Mean | 61·9 |
| 810 *f. s.* | |
| 427 | 62·7 |
| 430 | 59·5 |
| Mean | 61·1 |
| 815 *f. s.* | |
| Mean | 57·9 |
| 820 *f. s.* | |
| 429 | 75·7 |
| 430 | 58·2 |
| Mean | 67·0 |
| 825 *f. s.* | |
| Mean | 74·3 |
| 830 *f. s.* | |
| 122 | 90·1 |
| 429 | 75·4 |
| 430 | 58·5 |
| Mean | 74·7 |
| 835 *f. s.* | |
| Mean | 74·9 |
| 840 *f. s.* | |
| 28 | 64·1 |
| 122 | 90·1 |
| 429 | 76·0 |
| 430 | 58·5 |
| Mean | 72·2 |
| 845 *f. s.* | |
| Mean | 74·5 |
| 850 *f. s.* | |
| 28 | 62·7 |
| 31 | 62·1 |
| 32 | 62·3 |
| 121 | 92·9 |
| 122 | 90·4 |
| 177 | 61·1 |
| 423 | 64·7 |
| 429 | 74·1 |
| 430 | 59·5 |
| Mean | 70·0 |
| 855 *f. s.* | |
| Mean | 69·6 |
| 860 *f. s.* | |
| 27 | 46·8 |
| 28 | 61·7 |
| 29 | 64·0 |
| 30 | 64·5 |
| 31 | 61·4 |
| 32 | 60·3 |
| 121 | 93·6 |
| 122 | 91·1 |
| 177 | 58·8 |
| 421 | 97·6 |
| 422 | 45·5 |
| 423 | 58·2 |
| 429 | 67·6 |
| Mean | 67·0 |
| 865 *f. s.* | |
| Mean | 66·1 |
| 870 *f. s.* | |
| 26 | 62·6 |
| 27 | 43·6 |
| 28 | 61·0 |
| 29 | 62·2 |
| 30 | 60·4 |
| 31 | 60·8 |
| 32 | 57·8 |
| 121 | 94·2 |
| 177 | 57·3 |
| 421 | 84·1 |
| 422 | 66·3 |
| 870 *f. s.* *continued.* | |
| 423 | 46·3 |
| 429 | 63·9 |
| Mean | 63·1 |
| 875 *f. s.* | |
| Mean | 62·4 |
| 880 *f. s.* | |
| 26 | 61·9 |
| 28 | 60·3 |
| 177 | 57·3 |
| 415 | 85·8 |
| 421 | 70·3 |
| 422 | 80·2 |
| 423 | 40·5 |
| 429 | 62·7 |
| Mean | 64·9 |
| 885 *f. s.* | |
| Mean | 75·3 |
| 890 *f. s.* | |
| 26 | 61·7 |
| 178 | 63·8 |
| 415 | 84·7 |
| 418 | 85·3 |
| 421 | 54·8 |
| 422 | 87·3 |
| Mean | 72·9 |
| 895 *f. s.* | |
| Mean | 74·1 |
| 900 *f. s.* | |
| 178 | 62·6 |
| 415 | 84·5 |
| 418 | 90·9 |
| 419 | 80·6 |
| 422 | 90·8 |
| Mean | 81·9 |
| 905 *f. s.* | |
| Mean | 79·8 |
| 910 *f. s.* | |
| 178 | 61·4 |
| 415 | 82·1 |
| 417 | 91·5 |
| 418 | 94·0 |
| 419 | 80·6 |
| Mean | 81·9 |
| 915 *f. s.* | |
| Mean | 80·2 |
| 920 *f. s.* | |
| 178 | 60·4 |
| 415 | 76·1 |
| 416 | 80·4 |
| 417 | 84·5 |
| 418 | 93·5 |
| 419 | 75·6 |
| Mean | 78·4 |
| 925 *f. s.* | |
| Mean | 75·6 |
| 930 *f. s.* | |
| 24 | 73·2 |
| 415 | 74·1 |
| 416 | 74·0 |
| 417 | 78·8 |
| 418 | 89·4 |
| 419 | 65·8 |
| Mean | 75·9 |
| 935 *f. s.* | |
| Mean | 71·1 |

| Round | $K_v$ |
|---|---|
| **940 *f. s.*** | |
| 20 | 57·1 |
| 24 | 72·5 |
| 25 | 68·3 |
| 415 | 77·4 |
| 416 | 68·2 |
| 417 | 72·8 |
| 418 | 83·0 |
| 419 | 60·2 |
| Mean | 69·9 |
| **945 *f. s.*** | |
| Mean | 75·9 |
| **950 *f. s.*** | |
| 20 | 56·5 |
| 24 | 71·9 |
| 25 | 67·6 |
| 51 | 82·8 |
| 223 | 98·1 |
| 224 | 108·5 |
| 225 | 107·3 |
| 227 | 91·5 |
| 412 | 46·6 |
| 415 | 81·2 |
| 416 | 64·3 |
| 417 | 70·4 |
| 419 | 58·0 |
| Mean | 77·3 |
| **955 *f. s.*** | |
| Mean | 75·9 |
| **960 *f. s.*** | |
| 20 | 55·8 |
| 21 | 57·9 |
| 24 | 71·4 |
| 25 | 67·1 |
| 51 | 82·1 |
| 222 | 68·2 |
| 223 | 92·3 |
| 224 | 102·2 |
| 225 | 107·3 |
| 227 | 81·9 |
| 412 | 58·0 |
| **960 *f. s.* *continued.*** | |
| 414 | 65·4 |
| 416 | 63·1 |
| 417 | 66·3 |
| 419 | 57·2 |
| Mean | 73·1 |
| **965 *f. s.*** | |
| Mean | 75·5 |
| **970 *f. s.*** | |
| 20 | 54·9 |
| 21 | 57·7 |
| 24 | 71·2 |
| 25 | 66·7 |
| 50 | 92·6 |
| 51 | 81·4 |
| 53 | 90·3 |
| 103 | 66·1 |
| 222 | 63·2 |
| 223 | 89·2 |
| 224 | 95·7 |
| 226 | 90·7 |
| 412 | 72·1 |
| 414 | 63·5 |
| 416 | 52·4 |
| 417 | 65·0 |
| Mean | 73·3 |
| **975 *f. s.*** | |
| Mean | 73·9 |
| **980 *f. s.*** | |
| 20 | 54·2 |
| 21 | 57·4 |
| 23 | 79·3 |
| 24 | 71·1 |
| 25 | 66·5 |
| 50 | 90·3 |
| 51 | 80·7 |
| 53 | 89·8 |
| 103 | 69·0 |
| 104 | 63·0 |
| 105 | 77·4 |
| **980 *f. s.* *continued.*** | |
| 162 | 92·6 |
| 412 | 83·4 |
| 413 | 62·6 |
| 414 | 63·5 |
| 417 | 65·0 |
| Mean | 72·9 |
| **985 *f. s.*** | |
| Mean | 72·9 |
| **990 *f. s.*** | |
| 20 | 53·7 |
| 21 | 57·1 |
| 23 | 78·7 |
| 24 | 71·1 |
| 25 | 66·1 |
| 49 | 68·3 |
| 50 | 85·8 |
| 51 | 80·0 |
| 52 | 72·7 |
| 53 | 88·6 |
| 54 | 81·5 |
| 103 | 71·7 |
| 105 | 81·7 |
| 160 | 75·2 |
| 161 | 70·9 |
| 162 | 91·3 |
| 412 | 89·3 |
| 413 | 64·6 |
| 414 | 68·7 |
| Mean | 74·6 |
| **995 *f. s.*** | |
| Mean | 74·8 |
| **1000 *f. s.*** | |
| 20 | 53·2 |
| 21 | 56·9 |
| 23 | 78·1 |
| 24 | 71·1 |
| 25 | 65·8 |
| 49 | 68·3 |
| **1000 *f. s.* *continued.*** | |
| 50 | 81·3 |
| 51 | 79·3 |
| 52 | 73·8 |
| 53 | 86·6 |
| 54 | 78·2 |
| 105 | 86·2 |
| 160 | 75·2 |
| 161 | 71·7 |
| 162 | 90·0 |
| 163 | 63·0 |
| 412 | 95·8 |
| 413 | 64·8 |
| 414 | 75·5 |
| Mean | 74·5 |
| **1005 *f. s.*** | |
| Mean | 73·8 |
| **1010 *f. s.*** | |
| 20 | 52·9 |
| 21 | 56·9 |
| 23 | 77·6 |
| 24 | 71·1 |
| 25 | 65·6 |
| 49 | 68·3 |
| 50 | 75·0 |
| 51 | 78·6 |
| 52 | 75·7 |
| 53 | 84·0 |
| 54 | 75·7 |
| 159 | 72·9 |
| 160 | 75·2 |
| 161 | 70·9 |
| 162 | 88·7 |
| 163 | 62·1 |
| 175 | 83·8 |
| 412 | 102·6 |
| 413 | 66·1 |
| 414 | 80·7 |
| Mean | 74·2 |
| **1015 *f. s.*** | |
| Mean | 73·9 |
| **1020 *f. s.*** | |
| 23 | 77·0 |
| 24 | 71·0 |
| 25 | 65·1 |
| 49 | 67·9 |
| 50 | 68·2 |
| 51 | 78·1 |
| 52 | 77·8 |
| 54 | 74·0 |
| 159 | 73·5 |
| 160 | 75·2 |
| 161 | 71·3 |
| 163 | 62·1 |
| 175 | 84·4 |
| 413 | 68·6 |
| 414 | 86·2 |
| Mean | 73·4 |
| **1025 *f. s.*** | |
| Mean | 75·6 |
| **1030 *f. s.*** | |
| 23 | 76·5 |
| 49 | 67·1 |
| 51 | 77·7 |
| 52 | 80·6 |
| 54 | 73·2 |
| 159 | 74·4 |
| 163 | 62·1 |
| 175 | 85·7 |
| 413 | 74·5 |
| 414 | 89·4 |
| Mean | 76·1 |
| **1035 *f. s.*** | |
| Mean | 81·0 |
| **1040 *f. s.*** | |
| 16 | 97·9 |
| 23 | 75·7 |
| 51 | 77·3 |
| 159 | 74·4 |
| 175 | 87·2 |
| 413 | 80·4 |
| 414 | 93·3 |
| Mean | 83·7 |
| **1045 *f. s.*** | |
| Mean | 89·6 |
| **1050 *f. s.*** | |
| 14 | 94·3 |
| 16 | 97·9 |
| 174 | 95·4 |
| 175 | 88·8 |
| 176 | 85·1 |
| 413 | 84·0 |
| Mean | 90·9 |
| **1055 *f. s.*** | |
| Mean | 91·6 |
| **1060 *f. s.*** | |
| 14 | 93·8 |
| 16 | 97·5 |
| 174 | 95·4 |
| 175 | 91·1 |
| 176 | 85·4 |
| 413 | 89·7 |
| Mean | 92·2 |
| **1070 *f. s.*** | |
| Mean | 104·5 |
| **1080 *f. s.*** | |
| 13 | 124·1 |
| 14 | 92·2 |
| 15 | 126·9 |
| 16 | 95·6 |
| 17 | 110·0 |
| 18 | 96·9 |
| 169 | 102·8 |
| 170 | 106·1 |
| 173 | 99·7 |
| 174 | 95·7 |
| 175 | 96·2 |
| 176 | 86·0 |
| 232 | 115·7 |
| 235 | 84·4 |
| 236 | 124·2 |
| 237 | 111·5 |
| 238 | 120.0 |
| Mean | 105·2 |

| Round | $K_v$ |
|---|---|
| 1090 *f. s.* | |
| Mean | 106·6 |
| 1100 *f. s.* | |
| 1 | 135·2 |
| 3 | 122·3 |
| 13 | 122·6 |
| 14 | 89·6 |
| 15 | 122·1 |
| 16 | 93·3 |
| 17 | 108·5 |
| 18 | 96·3 |
| 38 | 112·2 |
| 169 | 98·8 |
| 170 | 107·6 |
| 171 | 97·9 |
| 172 | 104·1 |
| 173 | 99·7 |
| 174 | 96·2 |
| 176 | 86·6 |
| 232 | 118·7 |
| 233 | 151·0 |
| 234 | 94·4 |
| 235 | 74·5 |
| 236 | 113·0 |
| 237 | 113·1 |
| 238 | 111·3 |
| Mean | 107·3 |
| 1110 *f. s.* | |
| Mean | 107·4 |
| 1120 *f. s.* | |
| 1 | 134·1 |
| 2 | 93·3 |
| 3 | 124·5 |
| 13 | 120·7 |
| 15 | 115·0 |
| 16 | 91·4 |
| 17 | 107·1 |
| 18 | 95·2 |
| 35 | 104·1 |
| 38 | 111·7 |
| 64 | 101·3 |
| 66 | 106·7 |
| 67 | 103·7 |
| 93 | 124·9 |
| 169 | 91·2 |
| 170 | 107·6 |
| 171 | 96·0 |
| 1120 *f. s.* *continued.* | |
| 172 | 103·2 |
| 173 | 98·9 |
| 174 | 97·1 |
| 176 | 86·6 |
| 236 | 111·5 |
| Mean | 105·7 |
| 1130 *f. s.* | |
| Mean | 107·2 |
| 1140 *f. s.* | |
| 1 | 133·5 |
| 2 | 94·7 |
| 3 | 125·7 |
| 4 | 115·2 |
| 16 | 89·7 |
| 17 | 105·7 |
| 18 | 94·4 |
| 35 | 104·3 |
| 38 | 111·1 |
| 61 | 130·2 |
| 64 | 101·3 |
| 66 | 104·2 |
| 67 | 102·2 |
| 88 | 116·0 |
| 91 | 89·5 |
| 93 | 131·6 |
| 139 | 100·9 |
| 141 | 118·0 |
| 143 | 113·1 |
| 171 | 95·4 |
| 172 | 103·2 |
| 173 | 97·3 |
| 174 | 97·6 |
| Mean | 107·6 |
| 1150 *f. s.* | |
| Mean | 109·3 |
| 1160 *f. s.* | |
| 1 | 132·8 |
| 2 | 97·5 |
| 3 | 126·1 |
| 4 | 110·4 |
| 17 | 104·2 |
| 19 | 114·1 |
| 1160 *f. s.* *continued.* | |
| 35 | 104·5 |
| 36 | 114·9 |
| 38 | 110·7 |
| 61 | 129·6 |
| 64 | 101·3 |
| 66 | 102·3 |
| 67 | 101·2 |
| 87 | 112·8 |
| 88 | 119·4 |
| 91 | 94·5 |
| 93 | 135·9 |
| 124 | 112·6 |
| 139 | 100·9 |
| 140 | 110·4 |
| 141 | 115·8 |
| 142 | 101·7 |
| 143 | 113·1 |
| 174 | 98·5 |
| 208 | 103·4 |
| 209 | 97·7 |
| 211 | 116·6 |
| 212 | 94·1 |
| Mean | 109·9 |
| 1170 *f. s.* | |
| Mean | 110·0 |
| 1180 *f. s.* | |
| 1 | 132·1 |
| 2 | 100·9 |
| 3 | 125·3 |
| 4 | 105·7 |
| 5 | 101·3 |
| 19 | 114·1 |
| 35 | 104·7 |
| 36 | 114·7 |
| 38 | 110·3 |
| 61 | 129·0 |
| 64 | 101·6 |
| 66 | 100·8 |
| 67 | 100·8 |
| 87 | 111·1 |
| 88 | 119·7 |
| 91 | 101·4 |
| 93 | 139·9 |
| 124 | 112·6 |
| 139 | 100·2 |
| 140 | 109·3 |
| 141 | 115·3 |
| 1180 *f. s.* *continued.* | |
| 142 | 100·9 |
| 143 | 113·7 |
| 208 | 106·2 |
| 209 | 99·1 |
| 210 | 96·3 |
| 211 | 125·6 |
| 212 | 87·8 |
| Mean | 110·0 |
| 1190 *f. s.* | |
| Mean | 109·9 |
| 1200 *f. s.* | |
| 2 | 104·2 |
| 3 | 123·2 |
| 4 | 101·4 |
| 5 | 96·1 |
| 35 | 104·8 |
| 36 | 114·2 |
| 37 | 114·0 |
| 38 | 110·0 |
| 61 | 128·5 |
| 64 | 102·3 |
| 66 | 99·7 |
| 67 | 100·5 |
| 86 | 94·2 |
| 87 | 111·1 |
| 88 | 115·9 |
| 89 | 106·7 |
| 92 | 88·5 |
| 94 | 110·9 |
| 112 | 114·4 |
| 124 | 112·6 |
| 126 | 113·7 |
| 139 | 99·1 |
| 140 | 107·0 |
| 141 | 113·0 |
| 142 | 100·9 |
| 143 | 115·1 |
| 148 | 107·8 |
| 149 | 112·8 |
| 150 | 103·4 |
| 209 | 100·6 |
| 210 | 96·2 |
| 240 | 99·3 |
| Mean | 106·9 |
| 1210 *f. s.* | |
| Mean | 107·0 |
| 1220 *f. s.* | |
| 6 | 144·5 |
| 7 | 116·0 |
| 10 | 121·0 |
| 12 | 123·5 |
| 33 | 130·5 |
| 35 | 105·0 |
| 36 | 113·6 |
| 37 | 113·8 |
| 38 | 109·5 |
| 43 | 106·0 |
| 61 | 127·9 |
| 64 | 103·0 |
| 66 | 98·7 |
| 67 | 100·5 |
| 87 | 111·1 |
| 94 | 109·9 |
| 112 | 113·4 |
| 124 | 112·3 |
| 126 | 112·5 |
| 131 | 107·9 |
| 132 | 104·4 |
| 133 | 111·5 |
| 134 | 117·8 |
| 140 | 102·5 |
| 141 | 111·0 |
| 142 | 98·4 |
| 143 | 116·4 |
| 148 | 107·0 |
| 149 | 113·2 |
| 150 | 102·6 |
| 152 | 107·6 |
| 153 | 102·4 |
| 229 | 84·7 |
| 239 | 100·2 |
| 240 | 93·3 |
| Mean | 110·1 |
| 1230 *f. s.* | |
| Mean | 110·1 |
| 1240 *f. s.* | |
| 6 | 141·0 |
| 7 | 114·7 |
| 9 | 116·6 |
| 10 | 119·9 |
| 12 | 122·5 |
| 33 | 130·0 |
| 1240 *f. s.* *continued.* | |
| 35 | 105·2 |
| 36 | 112·8 |
| 37 | 113·6 |
| 38 | 108·9 |
| 43 | 105·7 |
| 61 | 127·3 |
| 62 | 121·0 |
| 63 | 106·6 |
| 64 | 103·7 |
| 66 | 98·2 |
| 67 | 101·1 |
| 94 | 108·4 |
| 111 | 120·4 |
| 112 | 112·3 |
| 124 | 112·0 |
| 126 | 111·7 |
| 130 | 105·4 |
| 131 | 107·2 |
| 132 | 104·1 |
| 133 | 111·5 |
| 134 | 117·5 |
| 148 | 106·3 |
| 149 | 113·3 |
| 150 | 102·1 |
| 152 | 107·6 |
| 153 | 102·4 |
| 166 | 95·2 |
| 168 | 97·1 |
| 218 | 111·9 |
| 220 | 108·5 |
| 221 | 120·9 |
| 228 | 118·2 |
| 229 | 84·7 |
| 239 | 92·0 |
| 240 | 91·7 |
| Mean | 110·0 |
| 1250 *f. s.* | |
| Mean | 110·2 |
| 1260 *f. s.* | |
| 6 | 138·2 |
| 7 | 112·9 |
| 9 | 115·5 |
| 10 | 118·9 |
| 11 | 121·8 |
| 12 | 121·1 |
| 33 | 129·6 |
| 34 | 94·0 |
| 35 | 105·4 |

| Round | $K_v$ |
|---|---|
| 1260 *f. s.* *continued.* | |
| 36 | 111·9 |
| 37 | 113·5 |
| 38 | 108·6 |
| 40 | 106·0 |
| 43 | 105·5 |
| 62 | 121·0 |
| 63 | 105·4 |
| 64 | 104·4 |
| 66 | 97·9 |
| 67 | 101·9 |
| 94 | 106·3 |
| 96 | 121·6 |
| 111 | 119·4 |
| 112 | 111·3 |
| 124 | 111·6 |
| 126 | 111·1 |
| 130 | 105·1 |
| 131 | 106·7 |
| 132 | 103·9 |
| 133 | 111·5 |
| 134 | 117·2 |
| 148 | 105·8 |
| 149 | 113·3 |
| 150 | 101·8 |
| 151 | 107·5 |
| 152 | 107·6 |
| 153 | 102·2 |
| 164 | 110·2 |
| 165 | 100·2 |
| 166 | 93·7 |
| 167 | 101·5 |
| 168 | 96·3 |
| 218 | 111·0 |
| 219 | 117·0 |
| 220 | 119·0 |
| 221 | 119·7 |
| 228 | 124·0 |
| 229 | 84·7 |
| 239 | 84·8 |
| Mean | 109·6 |
| 1270 *f. s.* | |
| Mean | 111·0 |
| 1280 *f. s.* | |
| 6 | 136·1 |
| 7 | 110·3 |
| 9 | 114·4 |
| 1280 *f. s.* *continued.* | |
| 10 | 117·8 |
| 11 | 120·8 |
| 12 | 118·7 |
| 33 | 129·1 |
| 34 | 92·6 |
| 35 | 105·5 |
| 36 | 111·2 |
| 37 | 113·5 |
| 38 | 108·2 |
| 40 | 105·3 |
| 43 | 105·3 |
| 44 | 109·4 |
| 62 | 121·0 |
| 66 | 97·5 |
| 94 | 104·1 |
| 96 | 120·6 |
| 97 | 113·1 |
| 98 | 122·1 |
| 101 | 121·8 |
| 110 | 125·9 |
| 111 | 118·5 |
| 112 | 110·2 |
| 124 | 111·2 |
| 126 | 110·8 |
| 127 | 109·4 |
| 130 | 104·8 |
| 131 | 106·2 |
| 132 | 103·7 |
| 133 | 111·5 |
| 134 | 116·9 |
| 148 | 105·4 |
| 149 | 113·3 |
| 150 | 101·5 |
| 151 | 106·4 |
| 152 | 107·5 |
| 153 | 101·9 |
| 164 | 110·2 |
| 165 | 98·8 |
| 166 | 92·1 |
| 167 | 100·7 |
| 168 | 95·7 |
| 218 | 110·5 |
| 219 | 104·5 |
| 220 | 126·3 |
| 221 | 119·0 |
| Mean | 110·9 |
| 1290 *f. s.* | |
| Mean | 110·1 |
| 1300 *f. s.* | |
| 6 | 134·4 |
| 7 | 107·3 |
| 9 | 113·4 |
| 10 | 116·9 |
| 11 | 119·8 |
| 12 | 116·4 |
| 33 | 128·9 |
| 34 | 91·3 |
| 35 | 105·7 |
| 36 | 110·4 |
| 37 | 113·5 |
| 38 | 107·8 |
| 40 | 104·7 |
| 41 | 105·1 |
| 43 | 105·0 |
| 44 | 108·7 |
| 94 | 101·9 |
| 96 | 119·7 |
| 97 | 110·0 |
| 98 | 118·3 |
| 99 | 109·1 |
| 100 | 118·7 |
| 101 | 118·0 |
| 110 | 124·6 |
| 111 | 117·5 |
| 112 | 108·4 |
| 124 | 110·5 |
| 126 | 110·8 |
| 127 | 108·8 |
| 130 | 104·5 |
| 131 | 105·6 |
| 132 | 103·7 |
| 133 | 111·5 |
| 134 | 116·6 |
| 148 | 105·1 |
| 149 | 113·3 |
| 150 | 101·1 |
| 151 | 105·5 |
| 152 | 107·3 |
| 153 | 101·9 |
| 164 | 110·1 |
| 165 | 96·0 |
| 166 | 91·9 |
| 167 | 99·3 |
| 168 | 95·2 |
| 221 | 119·0 |
| Mean | 109·9 |
| 1310 *f. s.* | |
| Mean | 108·7 |
| 1320 *f. s.* | |
| 7 | 103·9 |
| 10 | 116·3 |
| 11 | 118·8 |
| 12 | 114·0 |
| 33 | 128·6 |
| 35 | 105·7 |
| 36 | 109·6 |
| 37 | 113·5 |
| 38 | 107·3 |
| 40 | 104·2 |
| 41 | 104·7 |
| 43 | 104·7 |
| 44 | 108·1 |
| 94 | 99·8 |
| 96 | 118·8 |
| 97 | 107·9 |
| 98 | 114·5 |
| 99 | 105·0 |
| 100 | 114·9 |
| 110 | 123·3 |
| 111 | 116·6 |
| 112 | 105·7 |
| 124 | 109·9 |
| 126 | 111·0 |
| 127 | 108·5 |
| 130 | 104·2 |
| 131 | 105·0 |
| 132 | 103·7 |
| 133 | 111·4 |
| 134 | 116·5 |
| 148 | 104·7 |
| 149 | 113·2 |
| 150 | 100·7 |
| 151 | 104·5 |
| 152 | 106·9 |
| 153 | 101·9 |
| 164 | 108·9 |
| 165 | 93·1 |
| 167 | 98·9 |
| Mean | 108·9 |
| 1330 *f. s.* | |
| Mean | 108·5 |
| 1340 *f. s.* | |
| 7 | 100·2 |
| 12 | 111·3 |
| 35 | 105·7 |
| 37 | 113·5 |
| 1340 *f. s.* *continued.* | |
| 40 | 103·8 |
| 41 | 104·3 |
| 43 | 104·5 |
| 44 | 107·5 |
| 96 | 117·9 |
| 98 | 110·8 |
| 99 | 102·5 |
| 100 | 110·1 |
| 126 | 111·4 |
| 127 | 108·3 |
| 130 | 103·9 |
| 131 | 104·6 |
| 132 | 103·7 |
| 133 | 111·2 |
| 134 | 116·4 |
| 148 | 104·5 |
| 149 | 112·9 |
| 150 | 100·5 |
| 151 | 103·6 |
| 152 | 106·6 |
| 153 | 101·9 |
| 164 | 107·7 |
| Mean | 107·3 |
| 1350 *f. s.* | |
| Mean | 106·5 |
| 1360 *f. s.* | |
| 7 | 96·6 |
| 40 | 103·4 |
| 41 | 103·8 |
| 43 | 104·3 |
| 44 | 106·8 |
| 99 | 101·6 |
| 100 | 106·4 |
| 126 | 112·0 |
| 127 | 108·2 |
| 130 | 103·8 |
| 131 | 104·2 |
| 132 | 103·7 |
| 133 | 111·1 |
| 134 | 116·3 |
| 148 | 104·5 |
| 149 | 112·4 |
| 152 | 106·3 |
| 153 | 101·9 |
| Mean | 106·0 |
| 1370 *f. s.* | |
| Mean | 106·5 |
| 1380 *f. s.* | |
| 40 | 103·3 |
| 41 | 103·6 |
| 43 | 104·3 |
| 44 | 106·1 |
| 127 | 108·2 |
| 130 | 103·6 |
| 131 | 103·8 |
| 132 | 103·5 |
| 133 | 111·0 |
| 134 | 116·1 |
| 153 | 101·9 |
| Mean | 105·9 |
| 1390 *f. s.* | |
| Mean | 105·6 |
| 1400 *f. s.* | |
| 40 | 103·1 |
| 41 | 103·3 |
| 43 | 104·3 |
| 44 | 105·5 |
| 127 | 108·3 |
| 130 | 103·5 |
| 131 | 103·4 |
| 132 | 103·2 |
| 133 | 110·9 |
| 134 | 116·1 |
| 154 | 99·8 |
| 155 | 110·2 |
| 156 | 107·5 |
| 157 | 108·6 |
| 158 | 98·9 |
| Mean | 105·8 |
| 1410 *f. s.* | |
| Mean | 105·6 |

| Round | $K_v$ |
|---|---|
| **1420** *f. s.* | |
| 39 | 108·2 |
| 40 | 103·0 |
| 41 | 102·8 |
| 43 | 104·2 |
| 44 | 104·9 |
| 116 | 89·6 |
| 127 | 108·6 |
| 130 | 103·4 |
| 131 | 103·1 |
| 132 | 102·7 |
| 133 | 110·9 |
| 134 | 116·1 |
| 154 | 98·6 |
| 155 | 107·3 |
| 156 | 105·1 |
| 157 | 105·9 |
| 158 | 98·3 |
| Mean | 104·3 |
| **1430** *f. s.* | |
| Mean | 103·4 |
| **1440** *f. s.* | |
| 39 | 108·0 |
| 40 | 103·2 |
| 41 | 102·4 |
| 43 | 104·1 |
| 44 | 104·4 |
| 114 | 105·6 |
| 116 | 90·1 |
| 127 | 108·9 |
| 130 | 103·4 |
| 131 | 102·9 |
| 132 | 102·2 |
| 133 | 110·9 |
| 154 | 97·6 |
| 155 | 104·6 |
| 156 | 102·7 |
| 157 | 103·1 |
| 158 | 97·7 |
| Mean | 103·0 |
| **1450** *f. s.* | |
| Mean | 102·5 |

| Round | $K_v$ |
|---|---|
| **1460** *f. s.* | |
| 39 | 107·9 |
| 40 | 103·3 |
| 41 | 101·9 |
| 43 | 104·0 |
| 44 | 103·7 |
| 113 | 98·2 |
| 114 | 104·8 |
| 116 | 90·5 |
| 127 | 109·4 |
| 129 | 98·9 |
| 130 | 103·4 |
| 132 | 101·6 |
| 133 | 110·9 |
| 154 | 96·6 |
| 155 | 102·0 |
| 156 | 100·2 |
| 157 | 100·3 |
| 158 | 97·2 |
| Mean | 101·9 |
| **1470** *f. s.* | |
| Mean | 101·1 |
| **1480** *f. s.* | |
| 39 | 107·7 |
| 40 | 103·5 |
| 41 | 101·4 |
| 43 | 104·0 |
| 44 | 103·1 |
| 113 | 97·8 |
| 114 | 104·0 |
| 116 | 91·0 |
| 127 | 109·8 |
| 129 | 98·9 |
| 130 | 103·4 |
| 132 | 100·9 |
| 133 | 110·9 |
| 147 | 90·9 |
| 154 | 96·1 |
| 155 | 99·3 |
| 156 | 98·1 |
| 157 | 97·3 |
| 158 | 96·7 |
| Mean | 100 8 |
| **1490** *f. s.* | |
| Mean | 99·6 |

| Round | $K_v$ |
|---|---|
| **1500** *f. s.* | |
| 39 | 107·6 |
| 40 | 103·8 |
| 41 | 101·0 |
| 43 | 104·0 |
| 44 | 102·6 |
| 113 | 97·3 |
| 114 | 102·8 |
| 116 | 91·5 |
| 130 | 103·4 |
| 132 | 100·1 |
| 145 | 93·2 |
| 147 | 90·9 |
| 154 | 95·9 |
| 155 | 96·7 |
| 156 | 95·9 |
| 157 | 94·4 |
| 158 | 96·2 |
| Mean | 98·7 |
| **1510** *f. s.* | |
| Mean | 97·3 |
| **1520** *f. s.* | |
| 39 | 107·5 |
| 40 | 104·0 |
| 41 | 100·6 |
| 44 | 102·2 |
| 113 | 96·9 |
| 114 | 101·7 |
| 116 | 91·9 |
| 117 | 96·4 |
| 145 | 92·7 |
| 146 | 88·7 |
| 147 | 90·9 |
| 154 | 95·6 |
| 155 | 94·0 |
| 156 | 93·8 |
| 157 | 91·4 |
| 158 | 95·6 |
| Mean | 96·5 |
| **1530** *f. s.* | |
| Mean | 96·1 |

| Round | $K_v$ |
|---|---|
| **1540** *f. s.* | |
| 39 | 107·4 |
| 40 | 104·4 |
| 41 | 100·2 |
| 44 | 101·7 |
| 113 | 96·3 |
| 114 | 100·5 |
| 115 | 104·0 |
| 116 | 92·3 |
| 117 | 95·2 |
| 145 | 92·2 |
| 146 | 88·7 |
| 147 | 90·7 |
| 154 | 95·3 |
| 155 | 91·4 |
| 156 | 91·7 |
| 157 | 88·4 |
| 158 | 95·1 |
| Mean | 96·2 |
| **1550** *f. s.* | |
| Mean | 95·5 |
| **1560** *f. s.* | |
| 40 | 104·7 |
| 44 | 101·1 |
| 113 | 95·5 |
| 114 | 99·3 |
| 115 | 102·9 |
| 116 | 92·7 |
| 117 | 94·0 |
| 145 | 91·7 |
| 146 | 88·7 |
| 147 | 90·4 |
| 154 | 95·1 |
| 155 | 88·7 |
| 156 | 89·6 |
| 157 | 85·2 |
| 158 | 94·6 |
| Mean | 94·3 |
| **1570** *f. s.* | |
| Mean | 93·0 |

| Round | $K_v$ |
|---|---|
| **1580** *f. s.* | |
| 44 | 100·5 |
| 113 | 94·3 |
| 114 | 98·2 |
| 115 | 101·8 |
| 116 | 92·8 |
| 117 | 93·1 |
| 145 | 91·3 |
| 146 | 88·7 |
| 147 | 90·4 |
| 154 | 94·9 |
| 155 | 86·1 |
| 156 | 87·5 |
| 157 | 81·8 |
| 158 | 94·1 |
| Mean | 92·5 |
| **1590** *f. s.* | |
| Mean | 91·4 |
| **1600** *f. s.* | |
| 113 | 93·2 |
| 115 | 100·7 |
| 117 | 92·4 |
| 145 | 91·0 |
| 146 | 88·6 |
| 147 | 90·3 |
| 154 | 94·6 |
| 155 | 83·4 |
| 156 | 85·4 |
| 157 | 78·4 |
| 158 | 93·6 |
| 472 | 87·3 |
| Mean | 89·9 |
| **1610** *f. s.* | |
| Mean | 88·9 |
| **1620** *f. s.* | |
| 115 | 99·6 |
| 145 | 90·7 |
| 146 | 88·3 |
| 147 | 90·1 |
| 154 | 94·4 |
| 155 | 80·7 |
| 156 | 83·3 |
| 158 | 93·2 |

| Round | $K_v$ |
|---|---|
| **1620** *f. s.* *continued.* | |
| 470 | 72·0 |
| 472 | 87·3 |
| Mean | 88·0 |
| **1630** *f. s.* | |
| Mean | 83·9 |
| **1640** *f. s.* | |
| 144 | 73·5 |
| 145 | 90·2 |
| 146 | 88·1 |
| 147 | 90·0 |
| 470 | 75·5 |
| 472 | 87·3 |
| Mean | 84·1 |
| **1650** *f. s.* | |
| Mean | 84·4 |
| **1660** *f. s.* | |
| 144 | 73·5 |
| 145 | 89·9 |
| 146 | 87·8 |
| 147 | 90·0 |
| 470 | 78·9 |
| 472 | 87·3 |
| Mean | 84·6 |
| **1670** *f. s.* | |
| Mean | 84·8 |
| **1680** *f. s.* | |
| 144 | 73·5 |
| 145 | 89·7 |
| 146 | 87·6 |
| 147 | 89·9 |
| 470 | 81·1 |
| 472 | 86·7 |
| Mean | 84·8 |

| Round | $K_v$ |
|---|---|
| 1690 *f. s.* | |
| Mean | 84·8 |
| 1700 *f. s.* | |
| 144 | 73·5 |
| 145 | 89·4 |
| 146 | 87·4 |
| 147 | 89·7 |
| 470 | 83·6 |
| 472 | 84·6 |
| Mean | 84·7 |
| 1710 *f. s.* | |
| Mean | 83·7 |
| 1720 *f. s.* | |
| 145 | 89·2 |
| 146 | 87·2 |
| 470 | 85·4 |
| 471 | 71·8 |
| 472 | 82·7 |
| Mean | 83·3 |
| 1730 *f. s.* | |
| Mean | 82·4 |
| 1740 *f. s.* | |
| 462 | 87·6 |
| 470 | 87·7 |
| 471 | 68·5 |
| 472 | 81·0 |
| Mean | 81·2 |
| 1750 *f. s.* | |
| Mean | 80·2 |
| 1760 *f. s.* | |
| 462 | 89·5 |
| 463 | 81·1 |
| 470 | 90·0 |
| 471 | 65·7 |
| Mean | 81·6 |
| 1770 *f. s.* | |
| Mean | 80·7 |
| 1780 *f. s.* | |
| 462 | 91·3* |
| 463 | 80·3 |
| Mean | 80·3 |
| 1790 *f. s.* | |
| Mean | 79·9 |
| 1800 *f. s.* | |
| 462 | 92·0* |
| 463 | 79·4 |
| Mean | 79·4 |
| 1810 *f. s.* | |
| Mean | 75·2 |
| 1820 *f. s.* | |
| 461 | 71·3 |
| 462 | 92·0* |
| 463 | 78·6 |
| Mean | 75·0 |
| 1830 *f. s.* | |
| Mean | 75·1 |
| 1840 *f. s.* | |
| 461 | 72·0 |
| 462 | 92·0* |
| 463 | 78 6 |
| Mean | 75·3 |
| 1850 *f. s.* | |
| Mean | 76·8 |
| 1860 *f. s.* | |
| 461 | 73·5 |
| 462 | 91·1 |
| 463 | 78·6 |
| 502 | 64·4 |
| Mean | 76·9 |
| 1870 *f. s.* | |
| Mean | 77·0 |
| 1880 *f. s.* | |
| 461 | 75·6 |
| 462 | 89·8 |
| 463 | 78·6 |
| 473 | 65·8 |
| 502 | 64·7 |
| Mean | 74·9 |
| 1890 *f. s.* | |
| Mean | 73·8 |
| 1900 *f. s.* | |
| 461 | 78·3 |
| 462 | 88·4 |
| 463 | 77·6 |
| 473 | 68·2 |
| 474 | 71·8 |
| 475 | 67·8 |
| 476 | 67·7 |
| 502 | 65·1 |
| Mean | 73·1 |
| 1910 *f. s.* | |
| Mean | 72·5 |
| 1920 *f. s.* | |
| 461 | 81·6 |
| 462 | 87·0 |
| 463 | 76·5 |
| 473 | 68·7 |
| 474 | 71·4 |
| 475 | 69·1 |
| 476 | 67·7 |
| 1920 *f. s.* *continued.* | |
| 477 | 67·7 |
| 502 | 65·1 |
| Mean | 72·8 |
| 1930 *f. s.* | |
| Mean | 71·4 |
| 1940 *f. s.* | |
| 473 | 69·5 |
| 474 | 71·0 |
| 475 | 70·8 |
| 476 | 68·1 |
| 477 | 68·4 |
| 502 | 65·1 |
| Mean | 68·8 |
| 1950 *f. s.* | |
| Mean | 69·4 |
| 1960 *f. s.* | |
| 473 | 70·2 |
| 474 | 70·7 |
| 475 | 72·1 |
| 476 | 68·3 |
| 477 | 68·8 |
| 479 | 66·8 |
| 497 | 74·5 |
| 502 | 65·0 |
| Mean | 69·6 |
| 1970 *f. s.* | |
| Mean | 68·7 |
| 1980 *f. s.* | |
| 473 | 70·6 |
| 474 | 70·7 |
| 475 | 73·3 |
| 476 | 68·3 |
| 477 | 69·5 |
| 479 | 66·8 |
| 481 | 61·2 |
| 1980 *f. s.* *continued.* | |
| 482 | 62·2 |
| 497 | 74·5 |
| 501 | 59·7 |
| 502 | 64·3 |
| Mean | 67·4 |
| 1990 *f. s.* | |
| Mean | 67·9 |
| 2000 *f. s.* | |
| 473 | 71·4 |
| 474 | 70·7 |
| 475 | 74·3 |
| 476 | 67·9 |
| 477 | 70·1 |
| 479 | 66·8 |
| 480 | 66·1 |
| 481 | 61·7 |
| 482 | 62·6 |
| 497 | 74·7 |
| 500 | 73·0 |
| 501 | 59·7 |
| 502 | 63·5 |
| Mean | 67·9 |
| 2010 *f. s.* | |
| Mean | 67·9 |
| 2020 *f. s.* | |
| 473 | 72·5 |
| 474 | 70·7 |
| 475 | 74·7 |
| 476 | 67·7 |
| 477 | 70·1 |
| 479 | 66·8 |
| 480 | 65·7 |
| 481 | 62·2 |
| 482 | 63·0 |
| 497 | 74·9 |
| 500 | 72·7 |
| 501 | 59·7 |
| 502 | 62·9 |
| Mean | 68·0 |
| 2030 *f. s.* | |
| Mean | 67·8 |
| 2040 *f. s.* | |
| 473 | 73·6 |
| 474 | 70·7 |
| 475 | 74·4 |
| 476 | 67·7 |
| 477 | 70·1 |
| 478 | 65·2 |
| 479 | 66·7 |
| 480 | 65·9 |
| 481 | 62·6 |
| 482 | 63·7 |
| 491 | 67·4 |
| 493 | 68·1 |
| 497 | 75·0 |
| 498 | 71·8 |
| 499 | 66·4 |
| 500 | 72·1 |
| 501 | 59·7 |
| 502 | 62·6 |
| Mean | 68·0 |
| 2050 *f. s.* | |
| Mean | 68·0 |
| 2060 *f. s.* | |
| 473 | 74·5 |
| 474 | 70·1 |
| 475 | 73·5 |
| 476 | 67·7 |
| 477 | 70·1 |
| 478 | 65·6 |
| 479 | 66·3 |
| 480 | 66·1 |
| 481 | 63·0 |
| 482 | 64·6 |
| 491 | 67·1 |
| 493 | 68·4 |
| 497 | 75·0 |
| 498 | 71·6 |
| 499 | 66·4 |
| 500 | 71·6 |
| 501 | 59·4 |
| 502 | 62·2 |
| Mean | 68·0 |
| 2070 *f. s.* | |
| Mean | 67·9 |

| Round | $K_v$ |
|---|---|
| 2080 *f. s.* | |
| 473 | 75·1 |
| 474 | 69·6 |
| 475 | 72·5 |
| 476 | 67·6 |
| 477 | 69·7 |
| 478 | 66·0 |
| 479 | 66·2 |
| 480 | 65·7 |
| 481 | 63·4 |
| 482 | 65·8 |
| 490 | 62·2 |
| 491 | 67·0 |
| 492 | 57·0 |
| 493 | 68·6 |
| 497 | 74·8 |
| 498 | 71·3 |
| 499 | 66·4 |
| 500 | 71·6 |
| 501 | 59·0 |
| 502 | 61·9 |
| Mean | 67·1 |
| 2090 *f. s.* | |
| Mean | 67·1 |
| 2100 *f. s.* | |
| 473 | 75·9 |
| 474 | 69·5 |
| 475 | 71·1 |
| 476 | 67·2 |
| 477 | 69·4 |
| 478 | 66·2 |
| 479 | 66·2 |
| 480 | 65·8 |
| 481 | 63·8 |
| 482 | 66·7 |
| 490 | 61·8 |
| 491 | 67·0 |
| 492 | 57·3 |
| 493 | 68·9 |
| 494 | 67·0 |
| 495 | 58·9 |
| 497 | 74·6 |
| 498 | 71·3 |
| 499 | 66·4 |
| 500 | 71·5 |
| 501 | 58·7 |
| 502 | 61·6 |
| Mean | 66·7 |
| 2110 *f. s.* | |
| Mean | 66·6 |
| 2120 *f. s.* | |
| 473 | 76·9 |
| 474 | 69·5 |
| 475 | 69·8 |
| 476 | 66·9 |
| 477 | 69·0 |
| 478 | 66·2 |
| 479 | 66·2 |
| 480 | 66·2 |
| 481 | 64·2 |
| 482 | 67·4 |
| 490 | 61·5 |
| 491 | 67·0 |
| 492 | 57·6 |
| 493 | 69·2 |
| 494 | 66·4 |
| 495 | 58·6 |
| 497 | 74·5 |
| 498 | 71·3 |
| 499 | 66·6 |
| 500 | 71·2 |
| 501 | 58·3 |
| Mean | 66·9 |
| 2130 *f. s.* | |
| Mean | 66·3 |
| 2140 *f. s.* | |
| 474 | 69·5 |
| 475 | 68·8 |
| 476 | 66·5 |
| 477 | 68·7 |
| 478 | 66·4 |
| 479 | 66·2 |
| 480 | 65·8 |
| 481 | 64·5 |
| 482 | 68·2 |
| 490 | 61·2 |
| 491 | 67·0 |
| 492 | 58·0 |
| 493 | 69·5 |
| 494 | 65·9 |
| 495 | 58·2 |
| 497 | 74·5 |
| 2140 *f. s.* *continued.* | |
| 498 | 71·3 |
| 499 | 66·9 |
| 500 | 71·0 |
| 501 | 58·0 |
| Mean | 66·3 |
| 2150 *f. s.* | |
| Mean | 66·3 |
| 2160 *f. s.* | |
| 477 | 68·3 |
| 478 | 66·8 |
| 479 | 66·2 |
| 480 | 65·6 |
| 481 | 64·9 |
| 482 | 68·9 |
| 490 | 60·9 |
| 491 | 67·3 |
| 492 | 58·3 |
| 493 | 69·8 |
| 494 | 65·3 |
| 495 | 57·9 |
| 497 | 74·3 |
| 498 | 71·3 |
| 499 | 67·2 |
| 500 | 70·7 |
| 501 | 58·0 |
| Mean | 66·0 |
| 2170 *f. s.* | |
| Mean | 65·9 |
| 2180 *f. s.* | |
| 478 | 66·4 |
| 479 | 66·5 |
| 480 | 65·6 |
| 481 | 65·3 |
| 482 | 69·6 |
| 490 | 60·6 |
| 491 | 67·5 |
| 492 | 58·6 |
| 493 | 70·0 |
| 494 | 64·8 |
| 495 | 57·4 |
| 497 | 74·0 |
| 2180 *f. s.* *continued.* | |
| 498 | 71·3 |
| 499 | 67·4 |
| 500 | 70·5 |
| 501 | 58·0 |
| Mean | 65·8 |
| 2190 *f. s.* | |
| Mean | 65·9 |
| 2200 *f. s.* | |
| 478 | 66·1 |
| 479 | 66·8 |
| 480 | 65·6 |
| 481 | 65·6 |
| 482 | 69·9 |
| 490 | 60·9 |
| 491 | 68·1 |
| 492 | 58·8 |
| 493 | 70·3 |
| 494 | 64·2 |
| 495 | 56·7 |
| 497 | 73·8 |
| 498 | 71·2 |
| 499 | 67·5 |
| 500 | 70·8 |
| 501 | 58·0 |
| Mean | 65·9 |
| 2210 *f. s.* | |
| Mean | 65·9 |
| 2220 *f. s.* | |
| 478 | 65·7 |
| 479 | 66·4 |
| 480 | 65·6 |
| 481 | 66·0 |
| 482 | 69·9 |
| 490 | 61·0 |
| 491 | 68·6 |
| 492 | 59·4 |
| 493 | 70·5 |
| 494 | 63·6 |
| 495 | 55·7 |
| 497 | 73·6 |
| 498 | 71·1 |
| 2220 *f. s.* *continued.* | |
| 499 | 67·5 |
| 500 | 71·1 |
| 501 | 58·0 |
| Mean | 65·9 |
| 2230 *f. s.* | |
| Mean | 65·8 |
| 2240 *f. s.* | |
| 480 | 65·3 |
| 482 | 69·7 |
| 490 | 60·8 |
| 491 | 69·3 |
| 492 | 60·1 |
| 493 | 70·7 |
| 494 | 63·1 |
| 495 | 55·1 |
| 497 | 73·3 |
| 498 | 70·8 |
| 499 | 67·7 |
| 500 | 71·6 |
| 501 | 58·0 |
| Mean | 65·8 |
| 2250 *f. s.* | |
| Mean | 65·8 |
| 2260 *f. s.* | |
| 482 | 69·3 |
| 490 | 60·7 |
| 491 | 70·1 |
| 492 | 60·6 |
| 493 | 70·7 |
| 494 | 62·6 |
| 495 | 54·8 |
| 497 | 73·1 |
| 498 | 70·4 |
| 499 | 68·0 |
| 500 | 72·1 |
| 501 | 58·0 |
| Mean | 65·9 |
| 2270 *f. s.* | |
| Mean | 65·5 |
| 2280 *f. s.* | |
| 490 | 60·9 |
| 491 | 70·8 |
| 492 | 61·1 |
| 493 | 70·7 |
| 494 | 62·1 |
| 495 | 53·8 |
| 497 | 72·9 |
| 498 | 69·9 |
| 499 | 68·0 |
| 500 | 72·3 |
| Mean | 66·3 |
| 2290 *f. s.* | |
| Mean | 65·5 |
| 2300 *f. s.* | |
| 490 | 61·1 |
| 491 | 71·5 |
| 492 | 61·4 |
| 493 | 70·7 |
| 494 | 61·8 |
| 495 | 52·6 |
| 498 | 69·5 |
| 499 | 67·7 |
| 500 | 72·6 |
| Mean | 65·4 |
| 2310 *f. s.* | |
| Mean | 65·4 |
| 2320 *f. s.* | |
| 490 | 61·1 |
| 491 | 71·9 |
| 492 | 61·6 |
| 493 | 70·7 |
| 494 | 61·5 |
| 495 | 51·6 |
| 498 | 69·0 |
| 499 | 67·5 |
| Mean | 64·4 |

| Round | $K_v$ |
|---|---|
| 2330 *f. s.* | |
| Mean | 62·8 |
| 2340 *f. s.* | |
| 485 | 51·1 |
| 491 | 72·1 |
| 492 | 61·6 |
| 493 | 70·6 |
| 494 | 61·3 |
| 495 | 50·6 |
| 498 | 68·5 |
| 499 | 67·5 |
| Mean | 62·9 |
| 2350 *f. s.* | |
| Mean | 62·8 |
| 2360 *f. s.* | |
| 485 | 51·4 |
| 491 | 72·3 |
| 492 | 61·6 |
| 493 | 70·4 |
| 494 | 61·1 |
| 495 | 49·4 |
| 498 | 68·3 |
| 499 | 67·5 |
| Mean | 62·8 |
| 2370 *f. s.* | |
| Mean | 60·5 |
| 2380 *f. s.* | |
| 485 | 52·0 |
| 486 | 49·9 |
| 488 | 49·9 |
| 491 | 72·6 |
| 492 | 61·6 |
| 493 | 70·2 |
| 494 | 60·9 |
| 498 | 68·1 |
| Mean | 60·7 |

| Round | $K_v$ |
|---|---|
| 2390 *f. s.* | |
| Mean | 58·4 |
| 2400 *f. s.* | |
| 485 | 52·5 |
| 486 | 49·9 |
| 487 | 54·9 |
| 488 | 49·5 |
| 491 | 72·8 |
| 492 | 61·6 |
| 493 | 70·2 |
| 494 | 60·6 |
| 496 | 53·4 |
| Mean | 58·4 |
| 2410 *f. s.* | |
| Mean | 57·8 |
| 2420 *f. s.* | |
| 483 | 51·5 |
| 485 | 53·1 |
| 486 | 49·9 |
| 487 | 54·3 |
| 488 | 49·3 |
| 493 | 70·2 |
| 494 | 60·3 |
| 496 | 53·1 |
| Mean | 55·2 |
| 2430 *f. s.* | |
| Mean | 53·0 |
| 2440 *f. s.* | |
| 483 | 51·5 |
| 485 | 53·7 |
| 486 | 49·9 |
| 487 | 53·7 |
| 488 | 49·3 |
| 494 | 60·0 |
| 496 | 53·0 |
| Mean | 53·0 |

| Round | $K_v$ |
|---|---|
| 2450 *f. s.* | |
| Mean | 51·9 |
| 2460 *f. s.* | |
| 483 | 51·5 |
| 485 | 54·7 |
| 486 | 49·9 |
| 487 | 53·2 |
| 488 | 49·3 |
| 489 | 47·7 |
| 496 | 53·0 |
| Mean | 51·3 |
| 2470 *f. s.* | |
| Mean | 51·4 |
| 2480 *f. s.* | |
| 483 | 51·5 |
| 485 | 55·7 |
| 486 | 50·0 |
| 487 | 52·9 |
| 488 | 49·3 |
| 489 | 47·7 |
| 496 | 52·7 |
| Mean | 51·4 |
| 2490 *f. s.* | |
| Mean | 51·5 |
| 2500 *f. s.* | |
| 483 | 51·5 |
| 485 | 57·1 |
| 486 | 50·3 |
| 487 | 52·6 |
| 488 | 49·4 |
| 489 | 47·7 |
| 496 | 52·2 |
| Mean | 51·5 |
| 2510 *f. s.* | |
| Mean | 51·7 |

| Round | $K_v$ |
|---|---|
| 2520 *f. s.* | |
| 483 | 51·5 |
| 485 | 58·5 |
| 486 | 50·4 |
| 487 | 52·4 |
| 488 | 49·8 |
| 489 | 48·0 |
| 496 | 51·8 |
| Mean | 51·8 |
| 2530 *f. s.* | |
| Mean | 51·9 |
| 2540 *f. s.* | |
| 483 | 51·5 |
| 485 | 59·9 |
| 486 | 50·4 |
| 487 | 52·2 |
| 488 | 50·1 |
| 489 | 48·1 |
| 496 | 51·5 |
| Mean | 52·0 |
| 2550 *f. s.* | |
| Mean | 52·0 |
| 2560 *f. s.* | |
| 483 | 51·2 |
| 485 | 61·1 |
| 486 | 50·5 |
| 487 | 51·9 |
| 488 | 50·3 |
| 489 | 47·9 |
| 496 | 51·4 |
| Mean | 52·0 |
| 2570 *f. s.* | |
| Mean | 52·1 |
| 2580 *f. s.* | |
| 483 | 50·9 |
| 485 | 62·4 |
| 486 | 50·7 |

| Round | $K_v$ |
|---|---|
| 2580 *f. s.* *continued.* | |
| 487 | 51·7 |
| 488 | 50·6 |
| 496 | 51·4 |
| Mean | 53·0 |
| 2590 *f. s.* | |
| Mean | 53·1 |
| 2600 *f. s.* | |
| 483 | 50·7 |
| 485 | 63·5 |
| 486 | 50·9 |
| 487 | 51·5 |
| 488 | 50·8 |
| 496 | 51·5 |
| Mean | 53·2 |
| 2610 *f. s.* | |
| Mean | 53·3 |
| 2620 *f. s.* | |
| 483 | 50·4 |
| 485 | 64·7 |
| 486 | 50·9 |
| 487 | 51·1 |
| 488 | 50·9 |
| 496 | 51·8 |
| Mean | 53·3 |
| 2630 *f. s.* | |
| Mean | 51·0 |
| 2640 *f. s.* | |
| 483 | 50·4 |
| 485 | 65·8* |
| 486 | 50·9 |
| 487 | 50·9 |
| 488 | 50·9 |
| 496 | 51·9 |
| Mean | 51·0 |

| Round | $K_v$ |
|---|---|
| 2650 *f. s.* | |
| Mean | 51·5 |
| 2660 *f. s.* | |
| 483 | 50·4 |
| 484 | 54·1 |
| 485 | 66·9* |
| 486 | 50·9 |
| 487 | 50·9 |
| 488 | 50·9 |
| 496 | 51·7 |
| Mean | 51·5 |
| 2670 *f. s.* | |
| Mean | 51·4 |
| 2680 *f. s.* | |
| 483 | 50·3 |
| 484 | 54·1 |
| 485 | 68·0* |
| 486 | 50·9 |
| 487 | 50·9 |
| 488 | 50·6 |
| 496 | 51·4 |
| Mean | 51·4 |
| 2690 *f. s.* | |
| Mean | 51·3 |
| 2700 *f. s.* | |
| 483 | 50·0 |
| 484 | 54·1 |
| 485 | 68·9* |
| 486 | 50·9 |
| 487 | 50·9 |
| 488 | 50·4 |
| 496 | 51·4 |
| Mean | 51·3 |
| 2710 *f. s.* | |
| Mean | 51·3 |

| Round | $K_v$ |
|---|---|
| 2720 *f. s.* | |
| 483 | 49·8 |
| 484 | 54·1 |
| 485 | 70·0* |
| 486 | 50·9 |
| 487 | 50·9 |
| 488 | 50·4 |
| 496 | 51·4 |
| Mean | 51·3 |
| 2730 *f. s.* | |
| Mean | 51·2 |
| 2740 *f. s.* | |
| 483 | 49·6 |
| 484 | 54·2 |
| 485 | 71·0* |
| 486 | 50·8 |
| 487 | 51·0 |
| 488 | 50·4 |
| 496 | 51·4 |
| Mean | 51·2 |
| 2750 *f. s.* | |
| Mean | 51·2 |
| 2760 *f. s.* | |
| 483 | 49·3 |
| 484 | 54·4 |
| 486 | 50·6 |
| 487 | 51·2 |
| 496 | 51·4 |
| Mean | 51·4 |
| 2770 *f. s.* | |
| Mean | 52·0 |
| 2780 *f. s.* | |
| 484 | 54·6 |
| 486 | 50·4 |
| 487 | 51·5 |
| 496 | 51·4 |
| Mean | 52·0 |

## 77. Corrected mean values of $K_v$ for Ogival-headed Projectiles. ($w = 534{\cdot}22$ grains.) Cubic Law.

| $v$ f.s. | Experimental values of $K_v$ | Corrections | Corrected values of $K_v$ | $v$ f.s. | Experimental values of $K_v$ | Corrections | Corrected values of $K_v$ |
|---|---|---|---|---|---|---|---|
| 430 | 130·6 | +10·1 | 140·7 | 775 | 81·9 | −3·8 | 78·1 |
| 435 | 133·6 | +5·5 | 139·1 | 780 | 80·3 | −2·7 | 77·6 |
| 440 | 133·6 | +3·9 | 137·5 | 785 | 75·6 | +1·5 | 77·1 |
| 465 | 129·9 | +0·2 | 130·1 | 790 | 69·7 | +6·9 | 76·6 |
| 470 | 130·6 | −1·9 | 128·7 | 795 | 74·6 | +1·5 | 76·1 |
| 475 | 120·1 | +7·3 | 127·4 | 800 | 62·1 | +13·5 | 75·6 |
| 530 | 120·2 | −6·0 | 114·2 | 805 | 61·9 | +13·2 | 75·1 |
| 535 | 118·8 | −5·7 | 113·1 | 810 | 61·1 | +13·5 | 74·6 |
| 540 | 112·6 | −0·6 | 112·0 | 815 | 57·9 | +16·3 | 74·2 |
| 545 | 107·2 | +3·8 | 111·0 | 820 | 67·0 | +6·9 | 73·9 |
| 550 | 102·8 | +7·2 | 110·0 | 825 | 74·3 | −0·6 | 73·7 |
| 555 | 101·5 | +7·5 | 109·0 | 830 | 74·7 | −1·1 | 73·6 |
| 560 | 98·1 | +9·9 | 108·0 | 835 | 74·9 | −1·3 | 73·6 |
| 565 | 99·5 | +7·6 | 107·1 | 840 | 72·2 | +1·4 | 73·6 |
| 570 | 100·5 | +5·6 | 106·1 | 845 | 74·5 | −0·9 | 73·6 |
| 575 | 98·6 | +6·6 | 105·2 | 850 | 70·0 | +3·6 | 73·6 |
| 580 | 99·7 | +4·6 | 104·3 | 855 | 69·6 | +4·0 | 73·6 |
| 585 | 102·6 | +0·8 | 103·4 | 860 | 67·0 | +6·6 | 73·6 |
| 590 | 100·9 | +1·6 | 102·5 | 865 | 66·1 | +7·5 | 73·6 |
| 595 | 112·9 | −11·2 | 101·7 | 870 | 63·1 | +10·5 | 73·6 |
| 600 | 100·6 | +0·2 | 100·8 | 875 | 62·4 | +11·2 | 73·6 |
| 605 | 113·2 | −13·2 | 100·0 | 880 | 64·9 | +8·7 | 73·6 |
| 650 | 95·5 | −2·4 | 93·1 | 885 | 75·3 | −1·7 | 73·6 |
| 655 | 96·5 | −4·1 | 92·4 | 890 | 72·9 | +0·7 | 73·6 |
| 660 | 97·7 | −6·0 | 91·7 | 895 | 74·1 | −0·5 | 73·6 |
| 665 | 99·6 | −8·6 | 91·0 | 900 | 81·9 | −8·3 | 73·6 |
| 670 | 99·9 | −9·6 | 90·3 | 905 | 79·8 | −6·2 | 73·6 |
| 675 | 100·1 | −10·5 | 89·6 | 910 | 81·9 | −8·3 | 73·6 |
| 680 | 98·6 | −9·6 | 89·0 | 915 | 80·2 | −6·6 | 73·6 |
| 685 | 97·5 | −9·2 | 88·3 | 920 | 78·4 | −4·8 | 73·6 |
| 690 | 96·4 | −8·7 | 87·7 | 925 | 75·6 | −2·0 | 73·6 |
| 695 | 90·7 | −3·7 | 87·0 | 930 | 75·9 | −2·3 | 73·6 |
| 700 | 86·7 | −0·3 | 86·4 | 935 | 71·1 | +2·5 | 73·6 |
| 705 | 84·9 | +0·9 | 85·8 | 940 | 69·9 | +3·7 | 73·6 |
| 710 | 81·1 | +4·1 | 85·2 | 945 | 75·9 | −2·3 | 73·6 |
| 715 | 80·2 | +4·4 | 84·6 | 950 | 77·3 | −3·7 | 73·6 |
| 720 | 82·6 | +1·4 | 84·0 | 955 | 75·9 | −2·3 | 73·6 |
| 725 | 81·0 | +2·4 | 83·4 | 960 | 73·1 | +0·5 | 73·6 |
| 730 | 81·1 | +1·8 | 82·9 | 965 | 75·5 | −1·9 | 73·6 |
| 735 | 77·2 | +5·1 | 82·3 | 970 | 73·3 | +0·3 | 73·6 |
| 740 | 77·3 | +4·5 | 81·8 | 975 | 73·9 | −0·3 | 73·6 |
| 745 | 78·0 | +3·2 | 81·2 | 980 | 72·9 | +0·7 | 73·6 |
| 750 | 83·0 | −2·3 | 80·7 | 985 | 72·9 | +0·7 | 73·6 |
| 755 | 83·2 | −3·1 | 80·1 | 990 | 74·6 | −1·0 | 73·6 |
| 760 | 83·5 | −3·9 | 79·6 | 995 | 74·8 | −1·2 | 73·6 |
| 765 | 85·5 | −6·4 | 79·1 | 1000 | 74·5 | −0·9 | 73·6 |
| 770 | 84·6 | −6·0 | 78·6 | 1005 | 73·8 | −0·2 | 73·6 |

Corrected mean values of $K_v$ for Ogival-headed Projectiles—(*cont.*).

| $v$ *f. s.* | Experimental values of $K_v$ | Corrections | Corrected values of $K_v$ | $v$ *f. s.* | Experimental values of $K_v$ | Corrections | Corrected values of $K_v$ |
|---|---|---|---|---|---|---|---|
| 1010 | 74·2 | −0·4 | 73·8 | 1410 | 105·6 | −1·0 | 104·6 |
| 1015 | 73·9 | +0·2 | 74·1 | 1420 | 104·3 | −0·3 | 104·0 |
| 1020 | 73·4 | +1·2 | 74·6 | 1430 | 103·4 | 0 | 103·4 |
| 1025 | 75·6 | −0·2 | 75·4 | 1440 | 103·0 | −0·2 | 102·8 |
| 1030 | 76·1 | +0·5 | 76·6 | 1450 | 102·5 | −0·4 | 102·1 |
| 1035 | 81·0 | −2·6 | 78·4 | 1460 | 101·9 | −0·5 | 101·4 |
| 1040 | 83·7 | −2·9 | 80·8 | 1470 | 101·1 | −0·4 | 100·7 |
| 1045 | 89·6 | −5·8 | 83·8 | 1480 | 100·8 | −0·9 | 99·9 |
| 1050 | 90·9 | −3·6 | 87·3 | 1490 | 99·6 | −0·4 | 99·2 |
| 1055 | 91·6 | −0·8 | 90·8 | 1500 | 98·7 | −0·3 | 98·4 |
| 1060 | 92·2 | +1·8 | 94·0 | 1510 | 97·3 | +0·4 | 97·7 |
| 1065 | 92·5 | +4·1 | 96·6 | 1520 | 96·5 | +0·3 | 96·8 |
| 1070 | 104·5 | −5·8 | 98·7 | 1530 | 96·1 | 0 | 96·1 |
| 1080 | 105·2 | −3·0 | 102·2 | 1540 | 96·2 | −0·9 | 95·3 |
| 1090 | 106·6 | −1·7 | 104·9 | 1550 | 95·5 | −1·0 | 94·5 |
| 1100 | 107·3 | −0·4 | 106·9 | 1560 | 94·3 | −0·6 | 93·7 |
| 1110 | 107·4 | +1·0 | 108·4 | 1570 | 93·0 | −0·1 | 92·9 |
| 1120 | 105·7 | +3·5 | 109·2 | 1580 | 92·5 | −0·4 | 92·1 |
| 1130 | 107·2 | +2·4 | 109·6 | 1590 | 91·4 | −0·1 | 91·3 |
| 1140 | 107·6 | +2·0 | 109·6 | 1600 | 89·9 | +0·6 | 90·5 |
| 1150 | 109·3 | +0·3 | 109·6 | 1610 | 88·9 | +0·9 | 89·8 |
| 1160 | 109·9 | −0·3 | 109·6 | 1620 | 88·0 | +1·1 | 89·1 |
| 1170 | 110·0 | −0·4 | 109·6 | 1630 | 83·9 | +4·5 | 88·4 |
| 1180 | 110·0 | −0·4 | 109·6 | 1640 | 84·1 | +3·6 | 87·7 |
| 1190 | 109·9 | −0·3 | 109·6 | 1650 | 84·4 | +2·6 | 87·0 |
| 1200 | 106·9 | +2·7 | 109·6 | 1660 | 84·6 | +1·7 | 86·3 |
| 1210 | 107·0 | +2·6 | 109·6 | 1670 | 84·8 | +0·8 | 85·6 |
| 1220 | 110·1 | −0·5 | 109·6 | 1680 | 84·8 | +0·1 | 84·9 |
| 1230 | 110·1 | −0·5 | 109·6 | 1690 | 84·8 | −0·6 | 84·2 |
| 1240 | 110·0 | −0·4 | 109·6 | 1700 | 84·7 | −1·2 | 83·5 |
| 1250 | 110·2 | −0·6 | 109·6 | 1710 | 83·7 | −0·9 | 82·8 |
| 1260 | 109·6 | 0 | 109·6 | 1720 | 83·3 | −1·2 | 82·1 |
| 1270 | 111·0 | −1·4 | 109·6 | 1730 | 82·4 | −0·9 | 81·5 |
| 1280 | 110·9 | −1·3 | 109·6 | 1740 | 81·2 | −0·3 | 80·9 |
| 1290 | 110·1 | −0·5 | 109·6 | 1750 | 80·2 | +0·1 | 80·3 |
| 1300 | 109·9 | −0·5 | 109·4 | 1760 | 81·6 | −1·9 | 79·7 |
| 1310 | 108·7 | +0·4 | 109·1 | 1770 | 80·7 | −1·5 | 79·2 |
| 1320 | 108·9 | −0·1 | 108·8 | 1780 | 80·3 | −1·7 | 78·6 |
| 1330 | 108·5 | 0 | 108·5 | 1790 | 79·9 | −1·9 | 78·0 |
| 1340 | 107·3 | +0·8 | 108·1 | 1800 | 79·4 | −2·0 | 77·4 |
| 1350 | 106·5 | +1·2 | 107·7 | 1810 | 75·2 | +1·6 | 76·8 |
| 1360 | 106·0 | +1·2 | 107·2 | 1820 | 75·0 | +1·2 | 76·2 |
| 1370 | 106·5 | +0·3 | 106·8 | 1830 | 75·1 | +0·6 | 75·7 |
| 1380 | 105·9 | +0·4 | 106·3 | 1840 | 75·3 | −0·1 | 75·2 |
| 1390 | 105·6 | +0·2 | 105·8 | 1850 | 76·8 | −2·1 | 74·7 |
| 1400 | 105·8 | −0·6 | 105·2 | 1860 | 76·9 | −2·6 | 74·3 |

Corrected mean values of $K_v$ for Ogival-headed Projectiles—(*cont.*).

| $v$ *f. s.* | Experimental values of $K_v$ | Corrections | Corrected values of $K_v$ | $v$ *f. s.* | Experimental values of $K_v$ | Corrections | Corrected values of $K_v$ |
|---|---|---|---|---|---|---|---|
| 1870 | 77·0 | −3·2 | 73·8 | 2330 | 62·8 | −2·1 | 60·7 |
| 1880 | 74·9 | −1·6 | 73·3 | 2340 | 62·9 | −0·7 | 60·2 |
| 1890 | 73·8 | −1·0 | 72·8 | 2350 | 62·8 | −3·1 | 59·7 |
| 1900 | 73·1 | −0·9 | 72·2 | 2360 | 62·8 | −3·7 | 59·1 |
| 1910 | 72·5 | −0·8 | 71·7 | 2370 | 60·5 | −1·9 | 58·6 |
| 1920 | 72·8 | −1·6 | 71·2 | 2380 | 60·7 | −2·7 | 58·0 |
| 1930 | 71·4 | −0·6 | 70·8 | 2390 | 58·4 | −0·9 | 57·5 |
| 1940 | 68·8 | +1·6 | 70·4 | 2400 | 58·4 | −1·4 | 57·0 |
| 1950 | 69·4 | +0·6 | 70·0 | 2410 | 57·8 | −1·3 | 56·5 |
| 1960 | 69·6 | 0 | 69·6 | 2420 | 55·2 | +0·8 | 56·0 |
| 1970 | 68·7 | +0·6 | 69·3 | 2430 | 53·0 | +2·6 | 55·6 |
| 1980 | 67·4 | +1·6 | 69·0 | 2440 | 53·0 | +2·1 | 55·1 |
| 1990 | 67·9 | +0·9 | 68·8 | 2450 | 51·9 | +2·8 | 54·7 |
| 2000 | 67·9 | +0·6 | 68·5 | 2460 | 51·3 | +3·0 | 54·3 |
| 2010 | 67·9 | +0·3 | 68·2 | 2470 | 51·4 | +2·5 | 53·9 |
| 2020 | 68·0 | 0 | 68·0 | 2480 | 51·4 | +2·2 | 53·6 |
| 2030 | 67·8 | 0 | 67·8 | 2490 | 51·5 | +1·7 | 53·2 |
| 2040 | 67·0 | −0·3 | 67·7 | 2500 | 51·5 | +1·4 | 52·9 |
| 2050 | 68·0 | −0·5 | 67·5 | 2510 | 51·7 | +1·0 | 52·7 |
| 2060 | 68·0 | −0·6 | 67·4 | 2520 | 51·8 | +0·7 | 52·5 |
| 2070 | 67·9 | −0·6 | 67·3 | 2530 | 51·9 | +0·4 | 52·3 |
| 2080 | 67·1 | +0·1 | 67·2 | 2540 | 52·0 | +0·2 | 52·2 |
| 2090 | 67·1 | 0 | 67·1 | 2550 | 52·0 | 0 | 52·0 |
| 2100 | 66·7 | +0·3 | 67·0 | 2560 | 52·0 | −0·1 | 51·9 |
| 2110 | 66·6 | +0·3 | 66·9 | 2570 | 52·1 | −0·3 | 51·8 |
| 2120 | 66·9 | −0·1 | 66·8 | 2580 | 53·0 | −1·3 | 51·7 |
| 2130 | 66·3 | +0·4 | 66·7 | 2590 | 53·1 | −1·5 | 51·6 |
| 2140 | 66·3 | +0·3 | 66·6 | 2600 | 53·2 | −1·7 | 51·5 |
| 2150 | 66·3 | +0·2 | 66·5 | 2610 | 53·3 | −1·9 | 51·4 |
| 2160 | 66·0 | +0·4 | 66·4 | 2620 | 53·3 | −1·9 | 51·4 |
| 2170 | 65·9 | +0·4 | 66·3 | 2630 | 51·0 | +0·4 | 51·4 |
| 2180 | 65·8 | +0·3 | 66·1 | 2640 | 51·0 | +0·4 | 51·4 |
| 2190 | 65·9 | +0·1 | 66·0 | 2650 | 51·5 | −0·1 | 51·4 |
| 2200 | 65·9 | −0·1 | 65·8 | 2660 | 51·5 | −0·1 | 51·4 |
| 2210 | 65·9 | −0·3 | 65·6 | 2670 | 51·4 | 0 | 51·4 |
| 2220 | 65·9 | −0·6 | 65·3 | 2680 | 51·4 | 0 | 51·4 |
| 2230 | 65·8 | −0·7 | 65·1 | 2690 | 51·3 | 0 | 51·3 |
| 2240 | 65·8 | −0·9 | 64·9 | 2700 | 51·3 | 0 | 51·3 |
| 2250 | 65·8 | −1·2 | 64·6 | 2710 | 51·3 | 0 | 51·3 |
| 2260 | 65·9 | −1·7 | 64·2 | 2720 | 51·3 | 0 | 51·3 |
| 2270 | 65·5 | −1·8 | 63·7 | 2730 | 51·2 | 0 | 51·2 |
| 2280 | 66·3 | −3·1 | 63·2 | 2740 | 51·2 | 0 | 51·2 |
| 2290 | 65·5 | −2·8 | 62·7 | 2750 | 51·2 | 0 | 51·2 |
| 2300 | 65·4 | −3·2 | 62·2 | 2760 | 51·4 | −0·2 | 51·2 |
| 2310 | 65·4 | −3·7 | 61·7 | 2770 | 52·0 | −0·8 | 51·2 |
| 2320 | 64·4 | −3·2 | 61·2 | 2780 | 52·0 | −0·8 | 51·2 |

## 78. Report dated July 8, 1879.

| Round | $K_v$ | Round | $K_v$ | Round | $K_v$ | Round | $K_v$ | Round | $K_v$ | Round | $K_v$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1640 *f. s.* | | 1680 *f. s.* | | 1720 *f. s.* | | 1760 *f. s.* | | 1800 *f. s.* | | 1840 *f. s.* | |
| 467 | 106·4 | 467 | 106·4 | 467 | 106·4 | 464 | 106·4 | 467 | 106·4 | 467 | 105·9 |
| 468 | 127·2 | 468 | 123·6 | 468 | 119·4 | 468 | 112·0 | 468 | 100·8 | 468 | 89·0 |
| 469 | 113·1 | 469 | 114·2 | 469 | 113·9 | 469 | 113·9 | 469 | 113·4 | 469 | 113·1 |
| Mean | 115·6 | Mean | 114·7 | Mean | 113·2 | Mean | 110·8 | Mean | 106·9 | Mean | 102·7 |
| 1650 *f. s.* | | 1690 *f. s.* | | 1730 *f. s.* | | 1770 *f. s.* | | 1810 *f. s.* | | 1850 *f. s.* | |
| Mean | 115·3 | Mean | 114·3 | Mean | 112·7 | Mean | 109·9 | Mean | 106·0 | Mean | 101·6 |
| 1660 *f. s.* | | 1700 *f. s.* | | 1740 *f. s.* | | 1780 *f. s.* | | 1820 *f. s.* | | 1860 *f. s.* | |
| 467 | 106·4 | 467 | 106·4 | 467 | 106·4 | 467 | 106·4 | 467 | 106·4 | 467 | 105·6 |
| 468 | 125·4 | 468 | 121·7 | 468 | 116·0 | 468 | 107·0 | 468 | 94·8 | 468 | 83·4 |
| 469 | 113·1 | 469 | 113·9 | 469 | 113·9 | 469 | 113·9 | 469 | 113·4 | 469 | 113·1 |
| Mean | 115·0 | Mean | 114·0 | Mean | 112·1 | Mean | 109·1 | Mean | 104·9 | Mean | 100·7 |
| 1670 *f. s.* | | 1710 *f. s.* | | 1750 *f. s.* | | 1790 *f. s.* | | 1830 *f. s.* | | 1870 *f. s.* | |
| Mean | 115·1 | Mean | 113·6 | Mean | 111·5 | Mean | 108·0 | Mean | 103·7 | Mean | 99·6 |

## 79. Corrected mean values of $K_v$ for Projectiles with Hemispherical Heads. ($\omega = 534{\cdot}22$ grains.)

| Vel. *f. s.* | Mean $K_v$ | Correction | Corrected $K_v$ | Vel. *f. s.* | Mean $K_v$ | Correction | Corrected $K_v$ |
|---|---|---|---|---|---|---|---|
| 1100 | 132·6 | +0·4 | 133·0 | 1730 | 112·7 | 0 | $112{\cdot}7_{-\cdot6}$ |
| 1110 | 133·2 | −0·2 | 133·0 | 1740 | 112·1 | 0 | $112{\cdot}1_{-\cdot7}$ |
| 1120 | 133·7 | −0·7 | 133·0 | 1750 | 111·5 | +·1 | $111{\cdot}4_{-\cdot7}$ |
| 1130 | 134·3 | −1·3 | 133·0 | 1760 | 110·8 | −·1 | $110{\cdot}7_{-\cdot8}$ |
| 1140 | 134·9 | −1·9 | 133·0 | 1770 | 109·9 | 0 | $109{\cdot}9_{-\cdot9}$ |
| 1150 | 132·1 | +0·9 | 133·0 | 1780 | 109·1 | −·1 | $109{\cdot}0_{-1\cdot0}$ |
| 1160 | 130·2 | +2·8 | 133·0 | 1790 | 108·0 | 0 | $108{\cdot}0_{-1\cdot0}$ |
| ..... | ..... | ..... | ..... | 1800 | 106·9 | +·1 | $107{\cdot}0_{-1\cdot0}$ |
| 1640 | 115·6 | 0 | $115{\cdot}6_{-\cdot2}$ | 1810 | 106·0 | 0 | $106{\cdot}0_{-1\cdot1}$ |
| 1650 | 115·3 | +·1 | $115{\cdot}4_{-\cdot2}$ | 1820 | 104·9 | 0 | $104{\cdot}9_{-1\cdot1}$ |
| 1660 | 115·0 | +·2 | $115{\cdot}2_{-\cdot2}$ | 1830 | 103·7 | +·1 | $103{\cdot}8_{-1\cdot1}$ |
| 1670 | 115·1 | −·1 | $115{\cdot}0_{-\cdot3}$ | 1840 | 102·7 | 0 | $102{\cdot}7_{-1\cdot1}$ |
| 1680 | 114·7 | 0 | $114{\cdot}7_{-\cdot3}$ | 1850 | 101·6 | 0 | $101{\cdot}6_{-1\cdot0}$ |
| 1690 | 114·3 | +·1 | $114{\cdot}4_{-\cdot4}$ | 1860 | 100·7 | −·1 | $100{\cdot}6_{-1\cdot0}$ |
| 1700 | 114·0 | 0 | $114{\cdot}0_{-\cdot4}$ | 1870 | 99·6 | 0 | $99{\cdot}6_{-1\cdot0}$ |
| 1710 | 113·6 | 0 | $113{\cdot}6_{-\cdot4}$ | | | | |
| 1720 | 113·2 | 0 | $113{\cdot}2_{-\cdot5}$ | | | | |

## 80. Report dated July 8, 1879.

| Round | $K_v$ | Round | $K_v$ | Round | $K_v$ | Round | $K_v$ | Round | $K_v$ | Round | $K_v$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1530 *f. s.* | | 1590 *f. s.* | | 1650 *f. s.* | | 1710 *f. s.* | | 1770 *f. s.* | | 1830 *f. s.* | |
| Mean | 173·7 | Mean | 176·1 | Mean | 173·4 | Mean | 172·7 | Mean | 171·2 | Mean | 168·4 |
| 1540 *f. s.* | | 1600 *f. s.* | | 1660 *f. s.* | | 1720 *f. s.* | | 1780 *f. s.* | | 1840 *f. s.* | |
| 465 | 186·0 | 464 | 165·4 | 464 | 165·4 | 464 | 165·4 | 464 | 166·0 | 464 | 166·2 |
| 466 | 162·1 | 465 | 182·9 | 465 | 178·9 | 465 | 174·6 | 465 | 171·9 | 465 | 170·0 |
| Mean | 174·1 | 466 | 170·0 | 466 | 175·8 | 466 | 177·7 | 466 | 175·0 | 466 | 166·5 |
| | | Mean | 172·8 | Mean | 173·4 | Mean | 172·6 | Mean | 171·0 | Mean | 167·6 |
| 1550 *f. s.* | | 1610 *f. s.* | | 1670 *f. s.* | | 1730 *f. s.* | | 1790 *f. s.* | | 1850 *f. s.* | |
| Mean | 174·5 | Mean | 173·0 | Mean | 173·3 | Mean | 172·4 | Mean | 170·5 | Mean | 166·7 |
| 1560 *f. s.* | | 1620 *f. s.* | | 1680 *f. s.* | | 1740 *f. s.* | | 1800 *f. s.* | | 1860 *f. s.* | |
| 465 | 185·1 | 464 | 165·4 | 464 | 165·4 | 464 | 165·4 | 464 | 166·2 | 464 | 166·2 |
| 466 | 164·6 | 465 | 181·5 | 465 | 177·2 | 465 | 173·5 | 465 | 171·2 | 465 | 169·7 |
| Mean | 174·9 | 466 | 172·5 | 466 | 177·0 | 466 | 177·3 | 466 | 172·4 | 466 | 161·2 |
| | | Mean | 173·1 | Mean | 173·2 | Mean | 172·1 | Mean | 169·9 | Mean | 165·7 |
| 1570 *f. s.* | | 1630 *f. s.* | | 1690 *f. s.* | | 1750 *f. s.* | | 1810 *f. s.* | | | |
| Mean | 175·3 | Mean | 173·2 | Mean | 173·1 | Mean | 171·8 | Mean | 169·4 | | |
| 1580 *f. s.* | | 1640 *f. s.* | | 1700 *f. s.* | | 1760 *f. s.* | | 1820 *f. s.* | | | |
| 465 | 184·2 | 464 | 165·4 | 464 | 165·4 | 464 | 165·6 | 464 | 166·2 | | |
| 466 | 167·1 | 465 | 180·3 | 465 | 175·7 | 465 | 172·7 | 465 | 170·5 | | |
| Mean | 175·7 | 466 | 174·2 | 466 | 177·7 | 466 | 176·2 | 466 | 169·9 | | |
| | | Mean | 173·3 | Mean | 172·9 | Mean | 171·5 | Mean | 168·9 | | |

## 81. Corrected mean values of $K_v$ for Projectiles with Flat Heads. ($\omega = 534{\cdot}22$ grains.)

| Vel. *f.s.* | Mean $K_v$ | Correction | Corrected $K_v$ | Vel. *f.s.* | Mean $K_v$ | Correction | Corrected $K_v$ |
|---|---|---|---|---|---|---|---|
| 1530 | 173·7 | +0·6 | 174·3 +1 | 1710 | 172·7 | 0 | 172·7 −1 |
| 1540 | 174·1 | +0·3 | 174·4 0 | 1720 | 172·6 | 0 | 172·6 −2 |
| 1550 | 174·5 | −0·1 | 174·4 +1 | 1730 | 172·4 | 0 | 172·4 −3 |
| 1560 | 174·9 | −0·4 | 174·5 0 | 1740 | 172·1 | 0 | 172·1 −3 |
| 1570 | 175·3 | −0·8 | 174·5 −1 | 1750 | 171·8 | 0 | 171·8 −3 |
| 1580 | 175·7 | −1·3 | 174·4 −1 | 1760 | 171·5 | 0 | 171·5 −3 |
| 1590 | 176·1 | −1·8 | 174·3 −1 | 1770 | 171·2 | 0 | 171·2 −3 |
| 1600 | 172·8 | +1·4 | 174·2 −1 | 1780 | 171·0 | −0·1 | 170·9 −4 |
| 1610 | 173·0 | +1·1 | 174·1 −1 | 1790 | 170·5 | 0 | 170·5 −5 |
| 1620 | 173·1 | +0·9 | 174·0 −1 | 1800 | 169·9 | +0·1 | 170·0 −5 |
| 1630 | 173·2 | +0·7 | 173·9 −2 | 1810 | 169·4 | +0·1 | 169·5 −6 |
| 1640 | 173·3 | +0·4 | 173·7 −1 | 1820 | 168·9 | 0 | 168·9 −6 |
| 1650 | 173·4 | +0·2 | 173·6 −1 | 1830 | 168·4 | −0·1 | 168·3 −7 |
| 1660 | 173·4 | +0·1 | 173·5 −2 | 1840 | 167·6 | 0 | 167·6 −8 |
| 1670 | 173·3 | 0 | 173·3 −1 | 1850 | 166·7 | +0·1 | 166·8 −9 |
| 1680 | 173·2 | 0 | 173·2 −2 | 1860 | 165·7 | +0·2 | 165·9 |
| 1690 | 173·1 | +0·1 | 173·0 −1 | | | | |
| 1700 | 172·9 | 0 | 172·9 −2 | | | | |

## CHAPTER IV.

### DESCRIPTION AND USE OF THE GENERAL TABLES $S_v$ AND $T_v$.

82. It will be found sufficient for many practical purposes to neglect the effect of gravity and treat the motion of a projectile as if its path was a *straight line*. This will suffice for experimental purposes when it is desired to find the loss of velocity, or the time of flight over a *limited range*, the muzzle velocity being high and the elevation of the gun being small.

In calculating these general tables, for convenience the action of the air upon the projectile has been treated as an *accelerating* force, instead of a retarding force, because the results derived from the use of the Tables are the same in both cases, and the use of proportional parts is more simple in the case of an accelerating force, for then the time, space, and velocity all increase or decrease together.

83. The equation of motion when the accelerating force varies as the *square* of the velocity, is

$$v\frac{dv}{ds} = 2cv^2,$$

or, integrating, $\log_e v = 2cs + C,$

and supposing, when

$$v = 0, \quad t = 0, \quad v = V,$$

then $$\log_e \frac{v}{V} = 2cs,$$

or $$\frac{d^2}{w}s = \frac{1}{2c}\frac{d^2}{w}\log_e\frac{v}{V} = \frac{(1000)^2}{k}\log_e\frac{v}{V} \quad \ldots\ldots\ldots\ldots(1),$$

for $$2c = 2bv = K\frac{d^2}{w}\frac{v}{(1000)^2} = \left(K\frac{v}{1000}\right)\frac{d^2}{w}\left(\frac{1}{1000}\right)^2$$
$$= k\frac{d^2}{w}\left(\frac{1}{1000}\right)^2 \text{ suppose.}$$

For velocities of ogival-headed shot below 820 *f. s.*, $k = 60{\cdot}5$, which gives

$$\frac{d^2}{w}s = 38059 \log_{10}\left(\frac{v}{V}\right),$$

and for velocities of spherical shot below 840 *f. s.*, $k = 118{\cdot}3$, which gives

$$\frac{d^2}{w}s = 19464 \log_{10}\left(\frac{v}{V}\right).$$

84. Again $$\frac{d^2s}{dt^2} = \frac{dv}{dt} = 2cv^2,$$

and integrating

$$\frac{1}{V} - \frac{1}{v} = 2ct,$$

or $$\frac{d^2}{w}t = \frac{1}{2c}\frac{d^2}{w}\left(\frac{1}{V} - \frac{1}{v}\right) = \frac{1000}{k}\left(\frac{1000}{V} - \frac{1000}{v}\right) \text{.....(2).}$$

85. The equation of motion, when the accelerating force varies as the *cube* of the velocity, is

$$v\frac{dv}{ds} = 2bv^3,$$

and integrating

$$\frac{1}{V} - \frac{1}{v} = 2bs,$$

or $$\frac{d^2}{w}s = \frac{1}{2b}\frac{d^2}{w}\left(\frac{1}{V} - \frac{1}{v}\right) = \frac{(1000)^2}{K}\left\{\left(\frac{1000}{V}\right) - \left(\frac{1000}{v}\right)\right\} \text{...(3).}$$

86. Again $$\frac{d^2s}{dt^2} = \frac{dv}{dt} = 2bv^3.$$

Integrating $$\frac{1}{2V^2} - \frac{1}{2v^2} = 2bt$$

or $$\frac{d^2}{w}t = \frac{1}{4b}\frac{d^2}{w}\left(\frac{1}{V^2} - \frac{1}{v^2}\right) = \frac{500}{K}\left\{\left(\frac{1000}{V}\right)^2 - \left(\frac{1000}{v}\right)^2\right\} \text{.....(4).}$$

Also, since $$\frac{1}{V}-\frac{1}{v}=2bs,$$

therefore $$\frac{dt}{ds}=\frac{1}{V}-2bs,$$

and integrating $$t=\frac{s}{V}-bs^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5).$$

In calculating general tables formulæ (1) and (2), or (3) and (4) may be used so long as $k$ or $K$ respectively remain constant. But when $k$, or $K$ varies with the velocity, its value will require to be often changed, so that $k_v$ or $K_v$ may be supposed to remain constant through a change of velocity, say from $(v-5)$ to $(v+5)$ *f.s.* Intermediate values can afterward be found by interpolation. In this way General Tables XXIII. to XXVI. have been calculated.

87. The velocity of a projectile is generally found by measuring the time $t$ in seconds occupied by the projectile in passing over a range of $s$ feet, and dividing the number of feet by the number of seconds, the velocity in feet per second at the middle point of the range is approximately found in general. But where the accelerating or retarding force varies as the *cube* of the velocity, this is exactly true. For

$$\frac{1}{v}=\frac{1}{V}-2bs,$$

and if $v'$ be the velocity of the projectile at the distance $\frac{1}{2}s$, then

$$\frac{1}{v'}=\frac{1}{V}-bs.$$

But the measured velocity

$$=\frac{\text{space in feet}}{\text{time in seconds}}$$

$$=\frac{s}{\frac{s}{V}-bs^2}=\frac{1}{\frac{1}{V}-bs}=v'$$

= the velocity at the middle point of the range $s$.

88. Special tables of remaining velocities were given for elongated projectiles with various forms of heads in my Report

of 1866[1]; also for 7, 8 and 9-inch ogival-headed projectiles in the Report of 1868[2]; and for all the service spherical projectiles in the Report of 1869[3]; and also for ogival-headed projectiles fired from all the Service guns[4].

89. Suppose we have two projectiles of *similar external forms*, whose diameters are $d$, $d'$; and weights $w$, $w'$ respectively. Then by equation (3), we have

$$\frac{d^2}{w} s = (1000)^3 \int_V^v \frac{dv}{Kv^3} = \frac{d'^2}{w'} s',$$

for $K$, $v$, and $V$ are the same for both projectiles. Hence if we have calculated a table of ranges $s'$, in which a projectile ($d'$, $w'$) loses any given velocity, from this table we can calculate the range $s$, in which another *similarly shaped* projectile ($d$, $w$) will lose the same given velocity, for then

$$s = s' \frac{d'^2}{w'} \div \frac{d^2}{w}.$$

This led me in the first instance to calculate general tables where $\frac{d'^2}{w'} = 1$, which were first published in 1871 for both spherical and ogival-headed projectiles[5].

In the same way it may be shown that

$$t = t' \frac{d'^2}{w'} \div \frac{d^2}{w}.$$

The corresponding General Tables were first published in 1872[6].

90. The variation in the density of the air must greatly affect the motion of projectiles, as the resistance of the air is assumed to vary as its density. As already explained the coefficients for both elongated and spherical projectiles have now been calculated for such a density that one cubic foot of dry air would weigh 534·22 grains. This change has had the effect of increasing the values of $K$ given in the Report of 1868 by about 0·7 per cent. It is evident that, when any calculation of an experiment has to be made by the tables and methods given in this work, it will be

[1] Reports, &c. 1865—1870, p. 15. [2] Ib. pp. 49, 50. [3] Ib. p. 116.
[4] Remaining velocities, &c. 1871, and Proceedings of the R. A. Inst. VII. p. 337.
[5] Remaining velocities, pp. 47, 48, and Proceedings of the R. A. Inst. VII. pp. 391, 392. [6] Ib. VIII. p. 4.

necessary to introduce corrections in order to adapt the results obtained to the density of the air on the day of that experiment.

91. Those who use French measures generally adopt as their standard, such a density of the air that one cubic metre of dry air would weigh 1·206 kil., which gives the weight of a cubic foot of air 526·94 grains, or nearly 527 grains. Hence it appears that the English coefficients ought to be numerically 1·37 per cent. greater than the French coefficients; while the English coefficients of 1868 would exceed the French by about 0·7 per cent. But when a proper correction has been introduced to adapt the tables to the density of the air on any particular day then the results arrived at ought to be the same, whatever be the table made use of.

92. The corrections of the coefficients $k$ and $K$, for the density of the air, are applied as follows. On any particular day, the weight of a cubic foot of air is easily found from Glaisher's Tables, when observations have been made with the Barometer and with the dry and wet bulb Thermometers. Suppose that $\tau$ denotes the weight in grains of a cubic foot of air on that day, divided by 534·22 the standard weight in grains, then $\tau$ will be a constant for that round, provided the shot does not rise high enough to have its resistance sensibly affected by the diminishing density of the air. As $k$ and $K$ vary as the density of the air, they will have the values $\tau k$ and $\tau K$ adapted to the density of air on that particular day. By formula (4) we have

$$\frac{dt}{dv} = \frac{1}{2bv^3},$$

or

$$\frac{d^2}{w}t = (1000)^3 \int_V^v \frac{dv}{K_v v^3} = T_v - T_V$$

$$= \text{difference of two tabular numbers.}$$

But on the day above referred to every value of $K_v$ must be replaced by $\tau K_v$, where $\tau$ is constant, and $K_v$ is generally variable, then

$$\frac{d^2}{w}t = (1000)^3 \int_V^v \frac{dv}{\tau K_v v^3} = \frac{(1000)^3}{\tau} \int_V^v \frac{dv}{K_v v^3},$$

or

$$\tau \frac{d^2}{w}t = (1000)^3 \int_V^v \frac{dv}{K_v v^3} = T_v - T_V$$

$$= \text{difference of the same tabular numbers as before.}$$

And in the same way it may be proved that

$$\tau \frac{d^2}{w} s = \text{difference of tabular numbers}$$

$$= S_\theta - S_V.$$

93. Suppose now a change to be made in the *form* of the head of an elongated shot, and that it is found by experiment that it is necessary for this particular form of head to change the values of $K$ obtained from experiments made with ogival-headed shot struck with a radius of one diameter and a half to $\kappa K$, where $\kappa$ is constant.

Further, suppose that we are experimenting with a gun that gives a degree of steadiness different from that of the average of the experimental guns, so as to require coefficients $\sigma K$ to be used instead of $K$, where $\sigma$ is a constant.

Then as before, we shall find

$$\tau\kappa\sigma \frac{d^2}{w} t = T_\theta - T_V,$$

and

$$\tau\kappa\sigma \frac{d^2}{w} s = S_\theta - S_V.$$

In order to introduce these corrections into the results obtained by the use of the General Tables, or into the calculation of trajectories, we have only to find the value of $\tau\kappa\sigma \frac{d^2}{w}$ and use that value instead of $\frac{d^2}{w}$.

94. A table has been calculated so that, on referring to it with the readings of the Barometer and Thermometer, the value of $\log \tau$ can be obtained directly on the supposition that the air is $\frac{2}{3}$ds saturated with moisture with sufficient exactness for all practical purposes[1]. In calculating this Table XX., the weight in grains of a cubic foot of air $\frac{2}{3}$ds saturated with moisture, under a pressure of 29 inches of mercury, was found by Glaisher's Tables for each degree of temperature. Each of these numbers was divided by 534·22 the number of grains in the weight of the standard cubic foot of air,

[1] Proceedings of the R. A. Inst. XIII. p. 348.

and the resulting values of $\tau$ were adapted to heights 15 to 31 inches of the barometer.

95. Table XXI. gives the values of $\log \tau$ corresponding to various heights. In calculating this table the simple formula

$$z = c' \log \frac{h}{h'}$$

was made use of, where $h$ denotes the height of the barometer in inches at the lower station, $h'$ that at the upper station, and $z$ the difference in feet of the vertical heights of the two stations. Here the force of gravity, and the temperature of the air are supposed constant. The table has been calculated in the following manner.

$$\log \tau = \log \frac{h'}{h} = -\frac{z}{c'}$$

$$= N - \frac{100 \times n}{c'} = 0{\cdot}0729 - \frac{100 \times n}{64110} = 0{\cdot}0729 - 0{\cdot}00156n;$$

$n = 0$, $\log \tau = 0{\cdot}0729$; $n = 1$, $\log \tau = 0{\cdot}0729 - 0{\cdot}00156 = 0{\cdot}07134$;

$n = 2$, $\log \tau = 0{\cdot}0729 - 0{\cdot}00156 \times 2 = 0{\cdot}06978$, &c., &c.

96. From readings of the barometer, &c. the value of $\log \tau$ is found by Table XX. at the place of observation. On referring to Table XXI. suppose this value of $\log \tau$ is found opposite the height $H$ feet; then the tabular number found opposite $H + z$ feet, will be the approximate value of $\log \tau$ at a place $z$ feet higher than the place of observation. Table XXI. may be used when French measures are employed, if the heights expressed in feet in the table are converted into metres.

97. The resistance of the air to a projectile of weight $w$ and $d$ inches in diameter moving with the velocity $v$ is equal to

$$2b \frac{w}{g} v^2 = \frac{K}{g} d^2 \left(\frac{v}{1000}\right)^3.$$

In this way Table XXII. has been calculated for spherical and ogival-headed projectiles.

98. General tables have been calculated to connect velocity and range, and velocity and time of flight for both spherical and ogival-headed projectiles. See Tables XXIII. to XXVI. Similar

tables for French measures have also been given. See Tables XXX. to XXXIII. In the latter case we denote the diameter of the shot in centimetres by a; its weight in kilogrammes by p, and the force of gravity by g metres per second.

## EXAMPLES OF THE USE OF THE GENERAL TABLES.

99. (1) Suppose it was asked in what range and time an 11·52-inch ogival-headed shot weighing 600 lbs. would have its velocity reduced from 1420 to 1250 *f. s.* Here

$$d^2 \div w = (11{\cdot}52)^2 \div 600 = 0{\cdot}2212.$$

Let $s$ denote the required range, and $t$ the time of flight, then

($\omega = 534{\cdot}22$ grains)

$$\frac{d^2}{w} s = 0{\cdot}2212 s = S_{1420} - S_{1250} = 41638{\cdot}4 - 40750{\cdot}8 = 887{\cdot}6,$$

and therefore $s = 887{\cdot}6 \div 0{\cdot}2212 = 4013$ feet,

and $$\frac{d^2}{w} t = 0{\cdot}2212 t = 160{\cdot}9015 - 160{\cdot}2344 = 0{\cdot}6671,$$

and therefore $t = 0{\cdot}6671 \div 0{\cdot}2212 = 3''{\cdot}016.$

(2) Calculate the same example with the tables adapted for French measures. Here

$$a = 11{\cdot}52 \text{ in.} = 29{\cdot}26 \text{ cm.};$$
$$p = 600 \text{ lbs.} = 272{\cdot}16 \text{ kgs.}$$
$$1420 f. s. = 432{\cdot}81 \text{ m. s.},$$
$$1250 f. s. = 381{\cdot}0 \text{ m. s.},$$

and $a^2 \div p = 3{\cdot}146$ ($\omega = 527$ grains),

then $$\frac{a^2}{p} s' = \mathfrak{S}_{432{\cdot}81} - \mathfrak{S}_{381} = 183042 - 179141 = 3901,$$

or $s' = 3901 \div 3{\cdot}146 = 1240$ metres $= 4068$ feet,

and $$\frac{a^2}{p} t' = \mathfrak{T}_{432{\cdot}81} - \mathfrak{T}_{381} = 2320{\cdot}54 - 2310{\cdot}90 = 9{\cdot}64,$$

or $t' = 9{\cdot}64 \div 3{\cdot}146 = 3''{\cdot}065.$

As we have used the standard density for which each table was adapted, in order to make the results comparable, by (91) we must

reduce the French results by 1·37 per cent. Then the corrected value of $s'$ $= 4068 - 55 = 4013$ feet;

and the corrected value of $t'$

$$= 3''{\cdot}065 - 0''{\cdot}041 = 3''{\cdot}024.$$

(3) Suppose we wish to find the time of flight of a spherical projectile ($w = 163{\cdot}5$ lbs., $d = 10{\cdot}4$ in.) over a range of 5000 feet, the muzzle velocity being 1988 *f. s.* and $\omega = 534{\cdot}22$ grains. Here $d^2 \div w = 0{\cdot}6615$. In the first place we must find the velocity $v$ at the end of the range of 5000 feet. Here by Table XXIII.

$$S_v = S_{1988} - \frac{d^2}{w}\,5000 = 11383{\cdot}5 - 3307{\cdot}5 = 8076{\cdot}0 = S_{1045{\cdot}7}.$$

Therefore the terminal velocity

$$v = 1045{\cdot}7 \text{ } f.\,s.$$

We must now find in what time the velocity of the same shot would be reduced from 1988 *f. s.* to 1045·7. By Table XXIV.

$$\frac{d^2}{w}\,t = 0{\cdot}6615t = T_{1988} - T_{1045{\cdot}7} = 19{\cdot}4388 - 17{\cdot}0755 = 2{\cdot}3633.$$

Therefore $t = 2{\cdot}3633 \div 0{\cdot}6615 = 3''{\cdot}572$ the required time of flight.

(4) We will now solve the same problem using French measures:

a = diameter of spherical projectile $= 10{\cdot}4$ in. $= 26{\cdot}42$ c.m.;

p = its weight $= 163{\cdot}5$ lbs. $= 74{\cdot}16$ kgs.;

5000 feet $= 1524$ metres;

1988 *f. s.* $= 605{\cdot}93$ m. s.,

and $\omega = 527{\cdot}0$ grains.

This gives $\tau = 1{\cdot}0137$.

By Table XXX. we find

$$\mathfrak{S}_{\mathfrak{v}} = \mathfrak{S}_{605{\cdot}9} - \frac{a^2}{p}\tau s = 50043 - \frac{(26{\cdot}42)^2}{74{\cdot}16} \times 1{\cdot}0137 \times 1524$$

$$= 50043 - 14540 = 35503 = \mathfrak{S}_{318{\cdot}7},$$

$$\therefore\ \mathfrak{v} = 318{\cdot}7 \text{ m. s.} = 1045{\cdot}6 \text{ f. s.}$$

Next to find in what time $t$ the velocity of the given spherical shot would be reduced from 605·93 to 318·7 m.s. By Table

$$\frac{a^2}{p}\tau t = \mathfrak{T}_{605{\cdot}93} - \mathfrak{T}_{318{\cdot}7} = 280''{\cdot}343 - 246''{\cdot}27 = 34''{\cdot}073,$$

therefore $$t = \frac{34''{\cdot}073}{1{\cdot}0137} \times \frac{74{\cdot}16}{(26{\cdot}42)^2} = 3''{\cdot}571$$

very nearly as before where $\omega = 534{\cdot}22$ grs.

100. The General Tables calculated for ogival-headed projectiles may be used to calculate range and time of flight for elongated projectiles having other *forms* of head, provided $\kappa$ the ratio of their coefficients of resistance be known. In this case we shall have by (93)

$$\frac{d^2}{w}\kappa s = S_v - S_V \quad \text{and} \quad \frac{d^2}{w}\kappa t = T_v - T_V.$$

As an example we will take the three rounds (70) of flat-headed projectiles: Rounds 464—6, where $w = 70$ lbs., $d = 6$ ins.; Barometer 30·4 ins.; Dry bulb thermometer 42° F., Wet do. 41° F. These observations give the weight of a cubic foot of air by Glaisher's Tables 561·2 grains on the day of experiment, so that $\tau = 561{\cdot}2 \div 534{\cdot}22 = 1{\cdot}051$. Or, using the Table XX., we find directly $\log \tau = 0{\cdot}0160 + {\cdot}0057 = 0{\cdot}0217$ which gives $\tau = 1{\cdot}051$. The screens were 150 feet apart. The average of the times at which the three shots passed the third screen was 0″·16011; and the ninth screen was 0″·69015. Thus the mean time occupied by the shot in passing from the third to the ninth screen, or over 900 feet, was found by experiment to be 0″·5300. The third screen was passed with a mean velocity 1827·7 *f. s.*, and the ninth screen with a mean velocity of 1585 *f. s.* Referring to the Table XIV. of values of $K$ for flat-headed shot we may assume $\kappa_2 = 2{\cdot}06$ for the above range of velocity.

Then $$\frac{d^2}{w}\kappa_2\tau = \frac{36}{70} \times 2{\cdot}06 \times 1{\cdot}051 = 1{\cdot}1134,$$

and by Table XXVI.

$$\frac{d^2}{w}\kappa_2\tau t = T_{1827{\cdot}7} - T_{1585} = 161''{\cdot}9892 - 116''{\cdot}3993 = 0''{\cdot}5899,$$

therefore $$t = \frac{0''{\cdot}5899}{1{\cdot}1134} = 0''{\cdot}530,$$

which agrees with experiment. Again, by Table XXV.,

$$\frac{d^2}{w}\kappa_2\tau s = S_{1827{\cdot}7} - S_{1585} = 43388{\cdot}7 - 42384{\cdot}8 = 1003{\cdot}9,$$

therefore $$s = \frac{1003{\cdot}9}{1{\cdot}1134} = 901{\cdot}6 \text{ feet instead of } 900 \text{ feet.}$$

101. We will next take the three rounds 467—9 of hemispherical-headed projectiles (70), fired on a day when the height of the barometer was 30·25 inches; dry-bulb thermometer 45° F., and the wet ditto 42° F. These give $\tau = 1{\cdot}039$. The mean times of the shot passing the third and ninth screens were 0″·15923 and 0″·66713 respectively, giving 0″·5079 as the mean time, found by experiment, occupied by the projectiles in passing from the third to the ninth screen, or over 900 feet. Also the mean velocity at the third screen was 1856 *f. s.*; and 1692 *f. s.* at the ninth screen. Referring to the Table XIII. of values of $K$ for hemispherical-headed projectiles, it will be found that $\kappa_1 = 1{\cdot}38$ between the above specified velocities.

Then

$$\frac{d^2}{w}\kappa_1\tau = \frac{36}{70} \times 1{\cdot}38 \times 1{\cdot}039 = 0{\cdot}7374,$$

and, by Table XXVI.,

$$\frac{d^2}{w}\kappa_1\tau t = T_{1856} - T_{1692} = 162''{\cdot}0495 - 161''{\cdot}6766 = 0''{\cdot}3729,$$

therefore

$$t = \frac{0''{\cdot}3729}{0{\cdot}7374} = 0''{\cdot}506.$$

Again, by Table XXV.

$$\frac{d^2}{w}\kappa_1\tau s = S_{1856} - S_{1692} = 43499{\cdot}7 - 42838{\cdot}9 = 660{\cdot}8.$$

Therefore $s = \dfrac{660{\cdot}8}{0{\cdot}7374} = 896{\cdot}1$ feet instead of 900 feet.

In the above two cases we have the advantage of using the values of $\kappa_1$ and $\kappa_2$ derived from the examples we have calculated. But the tables used in the calculations were derived from experiments made with *ogival*-headed projectiles.

102. In order to show clearly in what way the results of experiments were made available for the public service, it seems advisable to give, not only references, but *specimens* as well, of the useful ballistic tables adapted for practical use, which were published by me from time to time.

103. In the report of the results obtained by the employment of elongated projectiles with various forms of heads (1866), tables of remaining velocities were given for each form of projectile for

intervals of 100 feet in range[1]. The following is an abridgment of the two tables for solid ogival-headed experimental projectiles struck with radii of one and of two diameters, compared with similar tables calculated by the accompanying general tables (1889) derived from experiments made with ogival-headed shot struck with a radius of one diameter and a half.

| $\frac{d^2}{w} = 0{\cdot}5584$ | | | | $\frac{d^2}{w} = 0{\cdot}5738$ | | |
|---|---|---|---|---|---|---|
| Distance | 1 diam. 1866 | 1½ diam. 1889 | Diff. | 2 diam. 1866 | 1½ diam. 1889 | Diff. |
| feet | *f. s.* | *f. s.* | | *f. s.* | *f. s.* | |
| 0 | 1500·0 | 1500·0 | 0 | 1500·0 | 1500·0 | 0 |
| 500 | 1434·3 | 1439·3 | +5·0 | 1435·6 | 1437·7 | +2·1 |
| 1000 | 1374·2 | 1381·2 | +7·0 | 1376·4 | 1378·1 | +1·7 |
| 1500 | 1318·9 | 1326·2 | +7·3 | 1322·0 | 1321·9 | −0·1 |
| 2000 | 1267·9 | 1274·7 | +6·8 | 1271·7 | 1269·2 | −2·6 |
| 2500 | 1220·7 | 1226·8 | +6·1 | 1225·1 | 1220·5 | −4·6 |
| 3000 | 1176·9 | 1182·4 | +5·5 | 1181·8 | 1175·4 | −6·4 |
| 3500 | 1136·1 | 1141·2 | +5·1 | 1141·4 | 1133·5 | −7·9 |
| 4000 | 1098·1 | 1102·8 | +4·7 | 1103·7 | 1094·9 | −8·8 |
| 4500 | 1062·6 | 1068·8 | +6·2 | 1068·4 | 1061·2 | −7·3 |

This comparison exhibits the value of the early experiments, for the calculated velocities of the ogival-headed projectiles struck with a radius of one diameter and a half, are generally less than those given for heads struck with a radius of two diameters, and greater than those given by a head struck with a radius of one diameter, as they ought to be.

104. In the Report on the resistance of the air to the motion of ogival-headed projectiles (July 23, 1868), tables were given of the remaining velocities of ogival-headed service shot when fired from 7, 8 and 9-inch M. L. guns[2], the projectiles being supposed to move under the action of the resistance of the air only. These tables were shortly afterwards reprinted in the *Proceedings* of the R. A. Institution[3], and in Colonel Owen's *Modern Artillery*[4]. These are the tables referred to by General Mayevski in his Treatise on *Balistique Extérieure*, which matter will require to

[1] Reports, &c. 1865—1870, p. 15.
[2] Ib. p. 49.
[3] Notes, 1868, p. 69.
[4] 1871, p. 430.

be noticed hereafter. The following is a copy of the complete table for the 7-inch gun, omitting decimals, where

$d = 6{\cdot}92$ in. $= 17{\cdot}58$ c. m.; $w = 115$ lbs. $= 52{\cdot}2$ kil.; $d^2 \div w = 0{\cdot}4164$.

| Distance | 0 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 |
|---|---|---|---|---|---|---|---|---|---|---|
| feet | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* |
| 0 | 1717 | 1706 | 1695 | 1685 | 1674 | 1663 | 1653 | 1643 | 1633 | 1623 |
| 1000 | 1613 | 1603 | 1593 | 1584 | 1575 | 1565 | 1556 | 1546 | 1537 | 1527 |
| 2000 | 1518 | 1509 | 1499 | 1490 | 1481 | 1472 | 1463 | 1455 | 1446 | 1437 |
| 3000 | 1428 | 1419 | 1410 | 1402 | 1393 | 1385 | 1377 | 1368 | 1360 | 1352 |
| 4000 | 1344 | 1336 | 1328 | 1320 | 1312 | 1304 | 1296 | 1288 | 1281 | 1273 |
| 5000 | 1266 | 1259 | 1252 | 1244 | 1237 | 1230 | 1223 | 1216 | 1209 | 1203 |
| 6000 | 1196 | 1189 | 1183 | 1176 | 1170 | 1164 | 1157 | 1151 | 1145 | 1140 |
| 7000 | 1134 | 1129 | 1123 | 1118 | 1113 | 1107 | 1102 | 1097 | 1091 | 1086 |
| 8000 | 1081 | 1076 | 1071 | 1066 | 1061 | 1056 | 1052 | 1048 | 1045 | 1041 |
| 9000 | 1038 | 1034 | 1031 | 1028 | 1024 | 1021 | 1018 | 1015 | 1011 | 1008 |
| 10000 | 1005 | 1002 | 999 | 996 | 992 | 989 | 986 | 983 | 980 | 977 |

105. Here it must be pointed out that the coefficients, by which the above table was calculated in 1868, were revised in the following year, as explained at the conclusion of the report on the experiments made with spherical projectiles as follows: "In order, however, to obtain a more satisfactory table of values of $2000b\frac{w}{d^2}$" (for ogival-headed projectiles) "we have commenced the re-calculation of the times of passing each screen expressed to *five* places of decimals of a second. In this manner we shall obtain a table of average values of $2000b'\frac{w}{d^2}$ derived from all the rounds of *elongated* shot fired, just as we have obtained a table of values of $2000b'\frac{w}{d^2}$ for *spherical* shot[1]." These results were printed shortly afterwards and they entirely superseded the first table of coefficients[2], although the alteration was not great.

Also in the Report on experiments made with spherical projectiles, the coefficients obtained by experiment were used in a manner similar to the above to calculate the remaining velocities of spherical projectiles fired from the service guns[3]. The same were reprinted in Tables of Remaining Velocities[4], &c.: in Colonel Owen's *Modern Artillery*[5]; and in the *Proceedings* of the R.A. Institution[6]. The following is an abridgment of this Table.

[1] Reports, &c., 1865—1870, p. 65.
[2] Ib. pp. 123—152.
[3] Ib. p. 116.
[4] 1871, p. 35.
[5] 1871, p. 432.
[6] 1871, p. 379.

"Table showing the Velocities of Spherical Solid Shot for the "undermentioned Guns at intervals of 100 feet, supposing the "Shot to move in a straight line, subject only to the Resistance of "the Air." Report, dated Feb. 13, 1869.

| Gun | $d^3 \div w$ | Gun | $d^3 \div w$ | Gun | $d^3 \div w$ |
|---|---|---|---|---|---|
| 15-in. | ·4898 | 32-pr. | 1·2161 | 9-pr. | 1·8422 |
| 150-pr. | ·6615 | 24-pr. | 1·3373 | 6-pr. | 2·1218 |
| 100-pr. | ·7766 | 18-pr. | 1·4648 | 3 pr. | 2·6564 |
| 68-pr. | ·9487 | 12-pr. | 1·6696 | | |

| Distance | 15-in. | 150-pr. | 100-pr. | 68-pr. | 32-pr. | 24-pr. | 18-pr. | 12-pr. | 9-pr. | 6-pr. | 3-pr. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| feet | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* | *f. s.* |
| 0 | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 |
| 100 | 2079 | 2072 | 2067 | 2059 | 2048 | 2043 | 2038 | 2030 | 2022 | 2011 | 1990 |
| 200 | 2058 | 2044 | 2033 | 2019 | 1998 | 1988 | 1978 | 1962 | 1947 | 1926 | 1886 |
| 300 | 2037 | 2016 | 2001 | 1980 | 1948 | 1935 | 1920 | 1896 | 1875 | 1845 | 1788 |
| 400 | 2017 | 1988 | 1970 | 1942 | 1900 | 1883 | 1863 | 1833 | 1806 | 1768 | 1696 |
| 1500 | 1805 | 1714 | 1654 | 1571 | 1449 | 1402 | 1349 | 1272 | 1215 | 1126 | 994 |
| 1600 | 1787 | 1691 | 1628 | 1541 | 1415 | 1366 | 1311 | 1233 | 1175 | 1086 | 957 |
| 1700 | 1769 | 1668 | 1603 | 1512 | 1381 | 1331 | 1275 | 1196 | 1137 | 1049 | 925 |
| 1800 | 1752 | 1645 | 1578 | 1484 | 1349 | 1297 | 1241 | 1161 | 1101 | 1015 | 897 |
| 1900 | 1735 | 1623 | 1553 | 1456 | 1318 | 1265 | 1208 | 1128 | 1068 | 984 | 873 |
| 2000 | 1717 | 1601 | 1529 | 1429 | 1288 | 1234 | 1176 | 1097 | 1036 | 956 | |
| 2100 | 1700 | 1580 | 1505 | 1403 | 1258 | 1204 | 1146 | 1068 | 1007 | 930 | |
| 2200 | 1683 | 1559 | 1482 | 1377 | 1230 | 1175 | 1117 | 1040 | 980 | 906 | |
| 2300 | 1667 | 1538 | 1459 | 1352 | 1203 | 1147 | 1090 | 1014 | 955 | 884 | |
| 2400 | 1650 | 1518 | 1437 | 1327 | 1176 | 1121 | 1065 | 990 | 932 | | |
| 2500 | 1633 | 1498 | 1415 | 1303 | 1151 | 1096 | 1041 | 968 | 911 | | |
| 2600 | 1617 | 1479 | 1394 | 1280 | 1127 | 1072 | 1018 | 946 | 892 | | |
| 2700 | 1601 | 1459 | 1373 | 1257 | 1104 | 1050 | 997 | 926 | | | |
| 2800 | 1585 | 1440 | 1352 | 1235 | 1082 | 1029 | 977 | 907 | | | |
| 2900 | 1570 | 1422 | 1331 | 1214 | 1061 | 1009 | 958 | 889 | | | |
| 3000 | 1554 | 1403 | 1311 | 1193 | 1041 | 990 | 940 | 871 | | | |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | | |
| 3500 | 1479 | 1316 | 1219 | 1097 | 955 | 906 | 857 | | | | |
| ..... | ..... | ..... | ..... | ..... | ..... | | | | | | |
| 4000 | 1409 | 1235 | 1136 | 1019 | 884 | | | | | | |
| ..... | ..... | ..... | ..... | ..... | | | | | | | |
| 4500 | 1343 | 1163 | 1065 | 954 | | | | | | | |
| ..... | ..... | ..... | ..... | ..... | | | | | | | |
| 5000 | 1281 | 1098 | 1005 | 898 | | | | | | | |
| ..... | ..... | ..... | ..... | | | | | | | | |
| 5500 | 1223 | 1042 | 952 | | | | | | | | |
| ..... | ..... | ..... | ..... | | | | | | | | |
| 6000 | 1170 | 993 | 906 | | | | | | | | |
| ..... | ..... | ..... | | | | | | | | | |
| 6500 | 1120 | 950 | | | | | | | | | |
| ..... | ..... | ..... | | | | | | | | | |
| 7000 | 1076 | 910 | | | | | | | | | |
| ..... | ..... | | | | | | | | | | |
| 7500 | 1036 | | | | | | | | | | |
| ..... | ..... | | | | | | | | | | |
| 8000 | 999 | | | | | | | | | | |

106. By the help of the Table given for the 7-inch gun, where $d'^2 \div w' = 0{\cdot}4164$, we may find in what range the velocity of a 10-inch ogival-headed projectile where $d^2 \div w = 0{\cdot}2424$, will be reduced from 1700 to 1300 f. s. and from 1300 to 1100 f. s. Referring to the Table (104), it is found that the 7-inch shot has its velocity reduced from 1700 to 1300 f. s. in a range

$$4550 - 155 \text{ feet} = 4395 \text{ feet}:$$

therefore the 10-inch shot would by (88) have its velocity reduced in like manner in a range

$$4395 \times (d'^2 \div w') \div (d^2 \div w) = 4395 \times 0{\cdot}4164 \div 0{\cdot}2424$$
$$= 7550 \text{ feet} = 2517 \text{ yards}.$$

In the same way it is found from the Table that the velocity of the 7-inch shot is reduced from 1300 to 1100 f. s. in a range $7640 - 4550 = 3090$ feet; therefore the 10-inch shot would suffer the same reduction of velocity in a range

$$3090 \times 0{\cdot}4164 \div 0{\cdot}2424 = 5307 \text{ feet} = 1769 \text{ yards};$$

where $\omega = 530{\cdot}6$ grains.

The same law holds good for spherical projectiles. From the Table, (105), it appears that the 15-inch spherical projectile has its velocity reduced from 2100 to 1409 f. s. in a range of 4000 feet, where $d'^2 \div w' = 0{\cdot}4898$. From this, we find that the velocity of the 100-pr. projectile, where $d^2 \div w = 0{\cdot}7766$, would have its velocity reduced in like manner from 2100 to 1409 f. s. in a range

$$4000 \times 0{\cdot}4898 \div 0{\cdot}7766 = 2523 \text{ feet}.$$

From the Special Table for the 100-pr. we find 2528 feet.

107. The following are specimens of my earliest General Tables for spherical and ogival-headed projectiles, which connect velocity and space, and velocity and time.

"A General Table for facilitating the Calculation of the Range "corresponding to a given loss of Velocity of any SPHERICAL "SHOT[1]." 1871.

| Distance | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|
| feet | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* |
| 0 | 2100·0 | 2095·6 | 2091·3 | 2086·9 | 2082·6 | 2078·3 | 2074·0 | 2069·6 | 2065·3 | 2061·0 |
| 100 | 2056·7 | 2052·5 | 2048·2 | 2043·9 | 2039·7 | 2035·5 | 2031·2 | 2027·0 | 2022·8 | 2018·6 |
| 200 | 2014·4 | 2010·2 | 2006·0 | 2001·9 | 1997·7 | 1993·6 | 1989·4 | 1985·3 | 1981·2 | 1977·1 |
| 300 | 1973·0 | 1968·9 | 1964·8 | 1960·7 | 1956·7 | 1952·6 | 1948·6 | 1944·6 | 1940·5 | 1936·5 |
| 400 | 1932·5 | 1928·5 | 1924·5 | 1920·5 | 1916·6 | 1912·6 | 1908·7 | 1904·7 | 1900·8 | 1896·9 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1600 | 1511·3 | 1508·3 | 1505·2 | 1502·2 | 1499·2 | 1496·2 | 1493·2 | 1490·2 | 1487·2 | 1484·2 |
| 1700 | 1481·2 | 1478·3 | 1475·3 | 1472·3 | 1469·4 | 1466·4 | 1463·5 | 1460·6 | 1457·7 | 1454·8 |
| 1800 | 1451·9 | 1449·0 | 1446·1 | 1443·2 | 1440·3 | 1437·5 | 1434·6 | 1431·7 | 1428·9 | 1426·1 |
| 1900 | 1423·2 | 1420·4 | 1417·6 | 1414·8 | 1412·0 | 1409·2 | 1406·4 | 1403·6 | 1400·8 | 1398·1 |
| 2000 | 1395·3 | 1392·6 | 1389·8 | 1387·1 | 1384·4 | 1381·6 | 1378·9 | 1376·2 | 1373·5 | 1370·8 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 4800 | 889·4 | 888·3 | 887·2 | 886·1 | 885·0 | 883·9 | 882·9 | 881·8 | 880·7 | 879·7 |
| 4900 | 878·6 | 877·5 | 876·5 | 875·4 | 874·3 | 873·3 | 872·2 | 871·2 | 870·1 | 869·1 |

108. "A General Table for facilitating the Calculation of "the Range corresponding to a given loss of Velocity of any "ELONGATED SHOT (Ogival Head)[2]." 1871.

| Distance | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|
| feet | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* | *f.s.* |
| 0 | 1700·0 | 1697·5 | 1695·1 | 1692·7 | 1690·3 | 1687·9 | 1685·5 | 1683·2 | 1680·8 | 1678·4 |
| 100 | 1676·0 | 1673·7 | 1671·3 | 1668·9 | 1666·6 | 1664·2 | 1661·9 | 1659·5 | 1657·2 | 1654·8 |
| 200 | 1652·5 | 1650·2 | 1647·9 | 1645·6 | 1643·3 | 1640·9 | 1638·6 | 1636·3 | 1634·0 | 1631·7 |
| 300 | 1629·4 | 1627·1 | 1624·8 | 1622·5 | 1620·2 | 1617·9 | 1615·6 | 1613·3 | 1611·1 | 1608·8 |
| 400 | 1606·5 | 1604·2 | 1601·9 | 1599·7 | 1597·4 | 1595·1 | 1592·8 | 1590·6 | 1588·3 | 1586·0 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 2000 | 1275·9 | 1274·1 | 1272·3 | 1270·6 | 1268·8 | 1267·1 | 1265·3 | 1263·6 | 1261·9 | 1260·1 |
| 2100 | 1258·4 | 1256·7 | 1255·0 | 1253·3 | 1251·6 | 1249·9 | 1248·2 | 1246·5 | 1244·8 | 1243·1 |
| 2200 | 1241·5 | 1239·8 | 1238·1 | 1236·4 | 1234·8 | 1233·1 | 1231·5 | 1229·8 | 1228·2 | 1226·5 |
| 2300 | 1224·9 | 1223·3 | 1221·6 | 1220·0 | 1218·4 | 1216·8 | 1215·2 | 1213·6 | 1212·0 | 1210·4 |
| 2400 | 1208·8 | 1207·2 | 1205·6 | 1204·0 | 1202·4 | 1200·9 | 1199·3 | 1197·7 | 1196·2 | 1194·6 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 5400 | 921·7 | 921·1 | 920·6 | 920·0 | 919·5 | 918·9 | 918·3 | 917·8 | 917·2 | 916·7 |
| 5700 | 905·4 | 904·8 | 904·3 | 903·8 | 903·3 | 902·7 | 902·2 | 901·7 | 901·1 | 900·7 |

The above Tables were to be used as follows. "Let an "elongated projectile of 400 lbs. be fired from a 10-inch gun with

[1] Remaining Velocity, &c. 1871, p. 47; and Proceedings of the R. A. Inst. VII. p. 391.

[2] Remaining Velocity, &c. 1871, p. 48; and Proceedings of the R. A. Inst. VII. p. 392.

"an initial velocity of 1270 f. s., and let it be required to find what "would be the velocity at a distance of 1000 yards = 3000 feet. "Here $d^2 \div w = 0{\cdot}246$ and the reduced range = $3000 \times 0{\cdot}246 = 738$ "feet. Referring to General Table, the initial velocity 1270 f. s. is "found corresponding to a distance 2033 feet, to which, adding "the *reduced* range 738 feet, we get 2771 feet, and at this distance "the velocity = 1152·6 f. s., which is the velocity which the 400-lb. "shot would have at 1000 yards from the gun[1]."

109. "A General Table for facilitating the Calculation of the "Time corresponding to a given loss of Velocity of any Spherical "Shot[2]." 1872.

| $v$ | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| *f.s.* | " | " | " | " | " | " | " | " | " | " |
| 189 | 0·0013 | ·0027 | ·0040 | ·0054 | ·0067 | ·0081 | ·0094 | ·0108 | ·0121 | ·0135 |
| 188 | ·0148 | ·0162 | ·0175 | ·0189 | ·0203 | ·0216 | ·0230 | ·0244 | ·0257 | ·0271 |
| ... | ..... | ..... | ..... | ..... | ..... | ..... | ... .. | ..... | ..... | ..... |
| 123 | 1·4056 | ·4090 | ·4125 | ·4160 | ·4195 | ·4230 | ·4265 | ·4300 | ·4336 | ·4371 |
| 122 | ·4407 | ·4442 | ·4478 | ·4513 | ·4549 | ·4585 | ·4620 | ·4656 | ·4692 | ·4728 |
| 121 | ·4764 | ·4800 | ·4836 | ·4873 | ·4909 | ·4945 | ·4982 | ·5018 | ·5055 | ·5092 |
| 120 | ·5129 | ·5166 | ·5203 | ·5240 | ·5277 | ·5315 | ·5352 | ·5390 | ·5428 | ·5465 |
| ... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 90 | 3·3280 | ·3377 | ·3474 | ·3571 | ·3668 | ·3766 | ·3864 | ·3962 | ·4060 | ·4159 |

110. "A General Table for facilitating the Calculation of the "Time corresponding to a given loss of Velocity of any Elongated "Shot (Ogival Head)[3]." 1872.

| $v$ | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| *f.s.* | " | " | " | " | " | " | " | " | " | " |
| 169 | 0·0024 | ·0049 | ·0073 | ·0098 | ·0122 | ·0146 | ·0171 | ·0195 | ·0220 | ·0244 |
| 168 | ·0269 | ·0294 | ·0318 | ·0343 | ·0368 | ·0393 | ·0418 | ·0443 | ·0468 | ·0493 |
| 167 | ·0518 | ·0543 | ·0569 | ·0594 | ·0619 | ·0644 | ·0669 | ·0695 | ·0720 | ·0745 |
| ... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 136 | ·9861 | ·9898 | ·9935 | ·9972 | ·0009 | ·0047 | ·0084 | ·0121 | ·0159 | ·0196 |
| 135 | 1·0234 | ·0272 | ·0309 | ·0347 | ·0385 | ·0423 | ·0461 | ·0499 | ·0537 | ·0575 |
| 134 | ·0614 | ·0652 | ·0690 | ·0729 | ·0767 | ·0806 | ·0844 | ·0883 | ·0922 | ·0960 |
| ... | ..... | ..... | ..... | ..... | .. ... | ..... | ..... | ..... | ..... | ..... |
| 113 | 2·0827 | ·0890 | ·0953 | ·1016 | ·1079 | ·1143 | ·1207 | ·1271 | ·1335 | ·1399 |
| 112 | ·1464 | ·1528 | ·1593 | ·1658 | ·1723 | ·1789 | ·1855 | ·1921 | ·1987 | ·2053 |
| 111 | ·2120 | ·2187 | ·2254 | ·2321 | ·2388 | ·2456 | ·2524 | ·2592 | ·2661 | ·2729 |
| ... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 70 | 10·8975 | ·9412 | ·9850 | ·0290 | ·0732 | ·1176 | ·1622 | ·2070 | ·2520 | ·2972 |

[1] Remaining Velocity, &c., p. 31; and Proceedings of the R. A. Inst. VII. p. 375, 1871.

[2] Proceedings of the R. A. Inst. VIII. p. 4. [3] Ib. p. 6.

The following instructions were given for the use of the above Tables, 1872.

EXAMPLE. "Suppose it was required to find by the help "of the General Table in what time the velocity of a 700-lb. "elongated shot would be reduced from 1344 to 1129 f. s. "Here $d = 11{\cdot}52$ inches and $d^2 \div w = {\cdot}1896$. By Table we find "$1''{\cdot}0806$ corresponding to a velocity 1344 f. s., and $2''{\cdot}1464$ "to a velocity 1129 f. s. Hence (time required) $\times d^2 \div w$ "$= 2''{\cdot}1464 - 1''{\cdot}0806 = 1''{\cdot}0658$, which gives the required time "$= 1''{\cdot}0658 \div {\cdot}1896 = 5''{\cdot}621$."

111. My mathematical Treatise On the Motion of Projectiles under the Action of Gravity and the Resistance of the Air, published in 1873, contained General Tables of values of $(d^2 \div w)\, s$ and $(d^2 \div w)\, t$, connecting velocity and space, and velocity and time, which were recalculated for both spherical and ogival-headed projectiles. The Tables for spherical projectiles extended from velocity 500 to 1900 f. s. (Tables X. and XI.), and those for ogival-headed projectiles from 540 to 1700 f. s. (Tables VIII. and IX.). These four Tables were reprinted in the Government Treatise on the Construction of Ordnance[1], 1877. The two Tables for ogival-headed shot were reprinted in the Proceedings of the R.A. Institution[2], 1878; also in the R.A. Handbook for Field Service[3], 1878; and in Major Sladen's Principles of Gunnery[4], 1879.

112. Professor Niven communicated a paper to the Royal Society[5] in 1877 on the approximate calculation of Trajectories of Projectiles, in which he made use of my two General Tables

$$\frac{d^2}{w}\, s, \text{ and } \frac{d^2}{w}\, t,$$

or $S_v$ and $T_v$ as he named them, for space and time, and gave a third Table $D_v$ of his own.

113. The experiments of 1878, 9 extended the coefficients of resistance to ogival-headed projectiles to all velocities between 400 and 2500 f. s. New General Tables for $S_v$ and $T_v$ were calculated by the help of these coefficients, and for the above men-

[1] pp. 359—366. [2] x. pp. 250—253. [3] pp. 292—301.
[4] pp. 55—58. [5] Proceedings, No. 181.

tioned limits of velocity which were printed as an Appendix to the Report on those experiments made with my Chronograph[1]. Immediately afterwards these two Tables were reprinted in the Manual of Gunnery for H.M. Fleet, 1880; and also in an abridged form in the article "Gunnery" in the new edition of the Encyclopædia Britannica, 1880.

114. Lastly, the coefficients given in the Final Report of 1880, enabled me to extend my General Tables for ogival-headed projectiles to all velocities between 100 and 2800 f. s. These General Tables were first printed as an Appendix to the "Final Report," 1880. They were subsequently reprinted in the Manual of Gunnery for H.M. Fleet, 1880; also in the Text Book of Gunnery by Major Mackinlay, R.A., 1883 and 1887; and in the Treatise on Small Arms by Colonel Bond, R.A., 1884 and 1888.

115. Although my coefficients of resistance were derived from experiments made with guns of 3 to 9-inch calibre, Major McClintock, R.A., has found by careful experiment that they hold good for small-arm bullets, for he remarks "The accuracy of rifle-"bullet trajectories calculated by means of Professor Bashforth's "Tables has been tested by firing a large number of rounds through "paper screens placed at different points along the range....The "screens were erected at intervals along a 500 yards and a "1000 yards range. The result of the experiments was most "satisfactory, the mean heights of the bullet-holes in the screens "agreeing closely with the heights found by calculation[2]."

[1] Report, &c. Part II. 1879, pp. 51—58.

[2] Proceedings of the R. A. Inst. XII. p. 569.

## CHAPTER V.

### CALCULATION OF TRAJECTORIES OF PROJECTILES.

116. THE following is an explanation of the principal symbols used—$g$ denotes the accelerating force of gravity and equals 32·191 f. s. in the Latitude of Greenwich. g (French measure) = 9·809 m. s., $w$ the weight of the shot in pounds, p the weight in kilogrammes, $d$ the diameter of the shot in inches, a the diameter in centimetres. $f$ the retarding effect of the air for a velocity of $v$ feet per second $= -2bv^3$ when supposed to vary as the *cube* of the velocity; or $= -2cv^2$ when supposed to vary as the *square* of the velocity; or $= -2ev^n$ when supposed to vary as the $n^{th}$ power of the velocity of the projectile.

$$K = 2b\frac{w}{d^2}(1000)^3;\quad k = 2c\frac{w}{d^2}(1000)^2;\quad k = K\frac{v}{1000}.$$

$x$, $y$ are the horizontal and vertical coordinates of the centre of gravity of the projectile, at the time $t$, when the shot has described an arc $s$. $\phi$ is the inclination to the horizon of the tangent to the trajectory at the point $x, y$. $v_\phi$ denotes the velocity of the shot in the ascending branch of the trajectory, when moving in a direction inclined to the horizon at an angle $\phi$, and $u_\phi$ is corresponding horizontal velocity so that $u_\phi = v_\phi \cos\phi$. $v_\phi'$ and $u_\phi'$ denote similar quantities in the descending branch of the trajectory. $\omega$ denotes the weight of a cubic foot of air in grains. $\Pi$ denotes the weight of a cubic metre of air in kilogrammes. When ogival-headed shot are mentioned in this treatise without any further particulars, it may be assumed that the heads are struck with a radius of one diameter and a half, which was the form used in the chief experiments. Elongated projectiles are all supposed to have a right-hand rotation about their own axes.

117. Suppose a projectile to be fired in a direction inclined at an angle $\alpha$ above the horizontal plane through the muzzle, to be acted upon by gravity $g$ in parallel lines, and by a retarding force $2e$ (velocity)$^n$ acting at every point in the direction of the tangent to the trajectory of the projectile at that point which is assumed to pass through the centre of gravity of the shot, then there will be no force tending to draw the projectile out of the vertical plane of projection. Let the point of projection be taken for the origin, and let the axes of coordinates $x$ and $y$ be respectively horizontal and vertical, and in the vertical plane of projection. Let $x$, $y$ be the coordinates of the centre of gravity of the shot at the time $t$, when the shot has described an arc $s$ of its trajectory.

The equations of motion are

$$\frac{d^2x}{dt^2} = -2e\left(\frac{ds}{dt}\right)^n \frac{dx}{ds} = -2e\left(\frac{ds}{dt}\right)^{n-1}\frac{dx}{dt},$$

and
$$\frac{d^2y}{dt^2} = -2e\left(\frac{ds}{dt}\right)^n \frac{dy}{ds} - g = -2e\left(\frac{ds}{dt}\right)^{n-1}\frac{dy}{dt} - g,$$

therefore
$$\frac{dx}{dt}\frac{d^2y}{dt^2} - \frac{dy}{dt}\frac{d^2x}{dt^2} = -g\frac{dx}{dt}.$$

As usual suppose
$$p = \frac{dy}{dx},$$

then
$$\frac{dp}{dt} = \frac{\dfrac{dx}{dt}\dfrac{d^2y}{dt^2} - \dfrac{d^2x}{dt^2}\dfrac{dy}{dt}}{\left(\dfrac{dx}{dt}\right)^2} = -\frac{g}{\dfrac{dx}{dt}},$$

or
$$\frac{dp}{dt}\frac{dx}{dt} = -g, \text{ and also } \frac{dp}{dx}\left(\frac{dx}{dt}\right)^2 = -g,$$

or
$$\frac{dt}{dp} = -\frac{u}{g}; \text{ and } \frac{dx}{dp} = -\frac{u^2}{g} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1).$$

118. Again
$$\frac{d^2x}{dt^2} = -2e\left(\frac{ds}{dt}\right)^n \frac{dx}{ds} = -2e\left(\frac{ds}{dx}\right)^{n-1}\left(\frac{dx}{dt}\right)^n,$$

or
$$\frac{du}{dt} = -2e\,(1+p^2)^{\frac{n-1}{2}}\,u^n.$$

Therefore
$$\frac{1}{u^{n+1}}\frac{du}{dt} = -2e\,(1+p^2)^{\frac{n-1}{2}}\frac{1}{u} = \frac{2e}{g}(1+p^2)^{\frac{n-1}{2}}\frac{dp}{dt} \text{ by (1).}$$

Integrating $$-\frac{1}{nu^n} = C + \frac{2e}{g}\int (1+p^2)^{\frac{n-1}{2}}\, dp.$$

At the vertex, let $u = u_0$.

Then we have

$$\frac{1}{u^n} = \frac{1}{u_0^n} - \frac{2e}{g}\, n \int (1+p^2)^{\frac{n-1}{2}}\, dp \quad \ldots\ldots\ldots\ldots\ldots\ldots (2);$$

$$= \frac{1}{u_0^n}\left\{1 - \frac{2eu_0^n}{g}\, n \int (1+p^2)^{\frac{n-1}{2}}\, dp\right\},$$

therefore

$$v = u \sec\phi = \frac{u_0 \sec\phi}{\left\{1 - \frac{2eu_0^n}{g}\, n \int (1+p^2)^{\frac{n-1}{2}}\, dp\right\}^{\frac{1}{n}}} \quad \ldots\ldots\ldots\ldots\ldots (3).$$

From (1) we have

$$\frac{dt}{dp} = -\frac{u}{g} = -\frac{u_0}{g} \frac{1}{\left\{1 - \frac{2eu_0^n}{g}\, n \int (1+p^2)^{\frac{n-1}{2}}\, dp\right\}^{\frac{1}{n}}} \quad \ldots\ldots\ldots\ldots\ldots (4).$$

Now $$\frac{2eu_0^n}{g} = \frac{M \times 2eu_0^n}{Mg}$$

$$= \frac{\text{Resistance of the air at the vertex to the shot}}{\text{weight of the shot}} \quad \ldots (5);$$

$$\therefore \quad t = -\frac{u_0}{g} \int_{\phi}^{\phi'} \frac{(1+p^2)\, d\phi}{\left\{1 - \frac{2eu_0^n}{g}\, n \int (1+p^2)^{\frac{n-1}{2}}\, dp\right\}^{\frac{1}{n}}} \quad \ldots\ldots\ldots\ldots\ldots (6),$$

since $$dp = d\tan\phi = \sec^2\phi\, d\phi = (1+p^2)\, d\phi.$$

Again by (1) we have

$$\frac{dx}{dp} = -\frac{u^2}{g} = -\frac{u_0^2}{g} \frac{1}{\left\{1 - \frac{2eu_0^n}{g} n \int (1+p^2)^{\frac{n-1}{2}}\, dp\right\}^{\frac{2}{n}}},$$

or $$x = -\frac{u_0^2}{g} \int_{\phi}^{\phi'} \frac{(1+p^2)\, d\phi}{\left\{1 - \frac{2eu_0^n}{g} n \int (1+p^2)^{\frac{n-1}{2}}\, dp\right\}^{\frac{2}{n}}} \quad \ldots\ldots\ldots\ldots\ldots (7),$$

and since $$\frac{dy}{dx} = p, \quad \frac{dy}{dp} = p\frac{dx}{dp}.$$

Hence $$y=-\frac{u_0^2}{g}\int_{\phi}^{\phi'}\frac{(p+p^3)\,d\phi}{\left\{1-\frac{2eu_0^n}{g}n\int(1+p^2)^{\frac{n-1}{2}}\,dp\right\}^{\frac{2}{n}}} \quad \ldots\ldots\ldots(8).$$

So also $$s=-\frac{u_0^2}{g}\int_{\phi}^{\phi'}\frac{(1+p^2)^{\frac{3}{2}}d\phi}{\left\{1-\frac{2eu_0^n}{g}n\int(1+p^2)^{\frac{n-1}{2}}\,dp\right\}^{\frac{2}{n}}} \quad \ldots\ldots\ldots(9).$$

119. Suppose that the retarding force varies as the *square* of the velocity, then

$$n=2;\quad 2e=2c=k\frac{d^2}{w}\frac{1}{(1000)^2};$$

and by (5) $$\frac{2eu_0^n}{g}=\frac{2cu_0^2}{g}=\frac{k}{g}\frac{d^2}{w}\left(\frac{u_0}{1000}\right)^2=\lambda \text{ suppose}\ldots\ldots\ldots(10),$$

also $$n\int(1+p^2)^{\frac{n-1}{2}}\,dp=2\int(1+p^2)^{\frac{1}{2}}\,dp$$

$$=\tan\phi\sec\phi+\log_e\tan\left(\frac{\pi}{4}+\frac{\phi}{2}\right)=Q_\phi \text{ (see Table VII.)},$$

and by (2) $$\left(\frac{1000}{u}\right)^2=\left(\frac{1000}{u_0}\right)^2-\frac{k}{g}\frac{d^2}{w}Q_\phi \ldots\ldots\ldots(11).$$

Therefore

by (3) $$\frac{v}{u_0}=\frac{\sec\phi}{\{1-\lambda Q_\phi\}^{\frac{1}{2}}}=\frac{1}{10^3}(v) \ldots\ldots\ldots(12),$$

by (6) $$t=-\frac{u_0}{g}\int_{\phi}^{\phi'}\frac{(1+p^2)\,d\phi}{\{1-\lambda Q_\phi\}^{\frac{1}{2}}}=-\frac{u_0}{10^4 g}\,({}_\phi t_\lambda{}^{\phi'}) \ldots\ldots\ldots(13),$$

by (7) $$x=-\frac{u_0^2}{g}\int_{\phi}^{\phi'}\frac{(1+p^2)\,d\phi}{\{1-\lambda Q_\phi\}}=-\frac{u_0^2}{10^4 g}\,({}_\phi x_\lambda{}^{\phi'}) \ldots\ldots\ldots(14),$$

by (8) $$y=-\frac{u_0^2}{g}\int_{\phi}^{\phi'}\frac{(p+p^3)\,d\phi}{\{1-\lambda Q_\phi\}}=-\frac{u_0^2}{10^4 g}\,({}_\phi y_\lambda{}^{\phi'}) \ldots\ldots\ldots(15),$$

by (9) $$s=-\frac{u_0^2}{g}\int_{\phi}^{\phi'}\frac{(1+p^2)^{\frac{3}{2}}d\phi}{\{1-\lambda Q_\phi\}}$$

$$=-\frac{u_0^2}{g}\int_{p}^{p'}\frac{(1+p^2)^{\frac{1}{2}}dp}{\{1-\lambda Q_\phi\}}$$

$$=\frac{u_0^2}{2\lambda g}\int_{\phi}^{\phi'}\frac{d\{1-\lambda Q_\phi\}}{\{1-\lambda Q_\phi\}}=\frac{u_0^2}{2\lambda g}\log_e\left\{\frac{1-\lambda Q_{\phi'}}{1-\lambda Q_\phi}\right\} \ldots\ldots(16).$$

Here $s$ the length of the arc of the trajectory is the only quantity that can be found by integration. The values of $(t)$, $(x)$ and $(y)$ calculated by quadratures and also of $(v)$, for useful values of $\lambda$ and $\phi$, will be found in Table IX.

120. Suppose next that the retarding force varies as the *cube* of the velocity, then

$$n = 3\,;\ 2e = 2b = K\frac{d^2}{w}\left(\frac{1}{1000}\right)^3,$$

and by (5)
$$\frac{2eu_0^n}{g} = \frac{2bu_0^3}{g} = \frac{K}{g}\frac{d^2}{w}\left(\frac{u_0}{1000}\right)^3 = \gamma \text{ suppose } (17),$$

also $$n\int(1+p^2)^{\frac{n-1}{2}}dp = 3\int(1+p^2)\,dp$$

$$= 3\tan\phi + \tan^3\phi = P_\phi \text{ (see Table XV.).}$$

By (2)
$$\left(\frac{1000}{u}\right)^3 = \left(\frac{1000}{u_0}\right)^3 - \frac{K}{g}\frac{d^2}{w}P_\phi \text{.....(18),}$$

by (3)
$$\frac{v}{u_0} = \frac{\sec\phi}{\{1-\gamma P_\phi\}^{\frac{1}{3}}} = \frac{1}{10^3}(\text{V}) \text{..... .....(19),}$$

by (6)
$$t = -\frac{u_0}{g}\int_{\phi'}^{\phi}\frac{(1+p^2)\,d\phi}{\{1-\gamma P_\phi\}^{\frac{1}{3}}} = -\frac{u_0}{10^4 g}({}^{\phi}\text{T}_{\gamma}{}^{\phi'}) \text{ .....(20),}$$

by (7)
$$x = -\frac{u_0^2}{g}\int_{\phi'}^{\phi}\frac{(1+p^2)\,d\phi}{\{1-\gamma P_\phi\}^{\frac{2}{3}}} = -\frac{u_0^2}{10^4 g}({}^{\phi}\text{X}_{\gamma}{}^{\phi'}) \text{ .....(21),}$$

by (8)
$$y = -\frac{u_0^2}{g}\int_{\phi'}^{\phi}\frac{(p+p^3)\,d\phi}{\{1-\gamma P_\phi\}^{\frac{2}{3}}} = -\frac{u_0^2}{10^4 g}({}^{\phi}\text{Y}_{\gamma}{}^{\phi'}) \text{ .....(22);}$$

(X), (Y) and (T) have been calculated by quadratures for useful values of $\gamma$ and $\phi$. These results and corresponding values of (V) will be found in Table XVI. Intermediate values of these quantities must be found by proportional parts or, where greater accuracy is required, by interpolation.

121. Lastly, suppose that the retarding force arising from the resistance of the air varies as the 6th power of the velocity, then

$$n = 6,$$

and $$n\int(1+p^2)^{\frac{n-1}{2}}dp = 6\int(1+p^2)^{\frac{5}{2}}dp$$

$$= \tan\phi\left\{\sec^5\phi + \frac{5}{4}\sec^3\phi + \frac{15}{8}\sec\phi\right\} + \frac{15}{8}\log_e\tan\left(\frac{\pi}{4}+\frac{\phi}{2}\right)$$

$$= W_\phi \text{ (see Table XVIII.)} \ldots\ldots\ldots\ldots\ldots\ldots (23),$$

and by (2) $$\left(\frac{1000}{u}\right)^6 = \left(\frac{1000}{u_0}\right)^6 - \frac{2e'}{g}(1000)^6 W_\phi$$

$$= \left(\frac{1000}{u_0}\right)^6 - \frac{L}{g}\frac{d^2}{w}W_\phi \ldots\ldots\ldots\ldots\ldots\ldots (24).$$

Tables for calculating the values of $x$, $y$ and $t$ have not been prepared for this case. Hence it will be necessary to use those prepared for the cubic or Newtonian Law or the General Tables after the velocity has been calculated.

Professor Greenhill has published some elaborate papers on the Motion of a Projectile in a resisting medium[1]. He also effects a complete solution when the resistance is supposed to vary as the cube of the velocity[2]. Professor Greenhill has also published papers on the Rotation required for the stability of an elongated projectile[3], and on "Drift[4]."

## EXAMPLES OF THE CALCULATION OF TRAJECTORIES.

122. We now proceed to give various examples of the use of this treatise in calculating trajectories of projectiles.

For the purpose of testing my coefficients we will make use of Range Tables, which have been carefully derived from actual experiment and where the muzzle velocity and "jump" have been measured. One of these Range Tables is that for the 6·3-inch Howitzer where the muzzle velocity is 751 f. s. These Range Tables were originally sent to me to show that my coefficients of 1879 did not give satisfactory results when tested by them. Certainly my *general* Tables could not be expected to apply to trajectories *so much curved*. But when the trajectory was broken up into short arcs and so properly calculated, the results agreed

[1] Proceedings of the R. A. Inst. XI. pp. 113, 589; XII. p. 17.
[2] Ib. XIV. p. 373. [3] Ib. X. p. 589. [4] Ib. XI. p. 124.

extremely well with the Range Tables[1]. For examples of heavy shot I have used the Range Table recently prepared with great care by Captain H. J. May, R.N., for 12-inch shot fired at elevations of 0° to 4°.[2] Further, I have used the Range Table of the 4-inch B.L. gun, in order to secure great variation of velocity. After the publication of Krupp's Tables this was the gun selected by Government in 1887 to be used in testing my coefficients of Resistance ($K$) on a *long* range, when they were found to be quite satisfactory, although originally obtained from experiments on *short* ranges.

6·3-inch Howitzer. Ranges calculated on a horizontal plane 6·5 feet below the muzzle, $d = 6{\cdot}27$ inches, $w = 70$ lbs., no allowance for "jump." Angles of departure 5°, 10°, 15°, 20°, 25°, 30° and 35°.

Muzzle velocity 751 f. s. Range Table derived from instructions for the service of field guns, 1879.

(1) $\alpha = 5°$, $V \cos 5° = 748{\cdot}1$.

By (11) we have $\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{748{\cdot}1}\right)^2 + \frac{k}{g}\frac{d^2}{w} Q_5$.

$$\log \frac{k}{g} = 0{\cdot}27402 \quad \text{Table IV.}$$

$$\log \frac{d^2}{w} = 9{\cdot}74944$$

$$\log \frac{k}{g}\frac{d^2}{w} = 0{\cdot}02346$$

$$\log Q_5 = 9{\cdot}24353$$

$$9{\cdot}26699$$

therefore $$\frac{k}{g}\frac{d^2}{w} Q_5 = 0{\cdot}1849$$

and $$\left(\frac{1000}{u_0}\right)^2 = 1{\cdot}7868 + 0{\cdot}1849 = 1{\cdot}9717.$$

By Table X. $$u_0 = 712{\cdot}16 \text{ f. s.}$$

By (10) $$\lambda = \frac{k}{g}\frac{d^2}{w}\left(\frac{u_0}{1000}\right)^2 = 0{\cdot}5353.$$

[1] Final Report, p. 45.

[2] Proceedings of the R. A. Inst. XIV. p. 356.

Now $\log \frac{1}{g} = 8{\cdot}49227$

and $\log u_0 = 2{\cdot}85258$

therefore $\log \frac{u_0}{g} = 1{\cdot}34485$

and $\log \frac{u_0^2}{g} = 4{\cdot}19743$

From Table IX., we obtain

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| $+5°$ | 0·5· | 916 | 40·7 | 895 | 1051 |
| | 0·6 $+\cdot1$ | 924 $+8$ | 41·2 $+\cdot5$ | 899 $+4$ | 1061 $+10$ |
| ,, | $+\cdot0353$ | $+3$ | $+\cdot2$ | $+1$ | $+3·5$ |
| ,, | 0·5353 | 919 | 40·9 | 896 | 1054·5 |

$${}_s x_0 = 919 \times \frac{u_0^2}{10^4 g}\,;\quad {}_s y_0 = 40{\cdot}9 \times \frac{u_0^2}{10^4 g}\,;\quad {}_s t_0 = 896 \times \frac{u_0}{10^4 g}\,;\quad v_s = 751{\cdot}0 \text{ f.s.}$$

$= 1448$ feet; $= 64{\cdot}4$ feet; $= 1''{\cdot}982$.

We have to limit the descending branch by the consideration that the shot has to fall 6·5 feet more than it rose. Or the value of $(y')$ for the descending branch must be as before 40·9, increased by

$$10^4 \times 6{\cdot}5 \div \frac{u_0^2}{g} = 4{\cdot}13,$$

or the value of $(y')$ for the descending branch must be

$$40{\cdot}9 + 4{\cdot}1 = 45{\cdot}0.$$

On referring to Table IX. for $\lambda = 0{\cdot}5$ and $\lambda = 0{\cdot}6$ it will be found that $(y') = 45{\cdot}0$ for some value of $\phi$ between $-5°$ and $-6°$. Hence we must calculate the values of $(x')$, $(y')$, $(t')$ and $(v')$ for $-5°$ and $-6°$ for $\lambda = 0{\cdot}5353$; and then by proportional parts we can find the value of $\phi$, $(x')$, $(t')$ and $(v')$ corresponding to

$$(y') = 45{\cdot}0,$$

| $\lambda$ | $\phi'$ | $(x')$ | $(y')$ | $(t')$ | $(v')$ |
|---|---|---|---|---|---|
| 0·5353 | $-5°$ | $+836$ | $-36{\cdot}1$ | $+856$ | $+960$ |
| | $-6°$ $-1$ | $+996$ $+160$ | $-51{\cdot}4$ $-15{\cdot}3$ | $+1023$ $+167$ | $+953$ $-7$ |
| ,, | $+0°{\cdot}42$ | $-67$ | $+6{\cdot}4$ | $-70$ | $+3$ |
| ,, | $-5°{\cdot}58$ | $+929$ | $-45{\cdot}0$ | $+953$ | $+956$ |

gives

${}_0x_{5\cdot58}$ =1464 feet; ${}_0y_{5\cdot58}=-70\cdot9$ feet; ${}_0t_{5\cdot58}=2''\cdot108$; $v'_{5\cdot58}=680\cdot8$ f.s.

But

${}_5x_0$ =1448 „ ${}_5y_0=+64\cdot4$ „ ${}_5t_0=1''\cdot982$

therefore

${}_5X_{5\cdot58}=971$ yards; ${}_5Y_{5\cdot58}=-6\cdot5$ „ ${}_5T_{5\cdot58}=4''\cdot09$

By Range Table

$X=978$ yards; $Y=-6\cdot5$ „ $T=4''\cdot29$

difference

$-7$ yards 0 $-0''\cdot20$

(2) $\alpha=10°$; $\left(\frac{1000}{u_0}\right)^2=1\cdot8281+0\cdot3742=2\cdot2023.$

By Table X., $u_0=673\cdot85$ f. s. and $\lambda=0\cdot4793$.

For the ascending branch by Table IX.,

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| 10° | 0·4793 | 1932 | 175·6 | 1845 | 1115 |

which give

${}_{10}x_0=2725\cdot3$ feet; ${}_{10}y_0=247\cdot7$ feet; ${}_{10}t_0=3''\cdot862$; $v_{10}=751\cdot3$ f. s.

For the descending branch

| $\phi'$ | $\lambda$ | $(x')$ | $(y')$ | $(t')$ | $(v')$ |
|---|---|---|---|---|---|
| −11°·39 | 0·4793 | +1841 | −180·2 | 1925 | 933·7 |

which give

${}_0x_{11\cdot39}=2596\cdot9$ ft.; ${}_0y_{11\cdot39}=-254\cdot2$ ft.; ${}_0t_{11\cdot39}=4''\cdot030$; $v'_{11\cdot39}=629\cdot2$ f.s.

But

${}_{10}x_0=2725\cdot3$ ft.; ${}_{10}y_0=247\cdot7$ ft.; ${}_{10}t_0=3''\cdot862$

${}_{10}X_{11\cdot39}=1774$ yards; ${}_{10}Y_{11\cdot39}=-6\cdot5$ ft.; ${}_{10}T_{11\cdot39}=7''\cdot892$

and by Range Table

$X=1789$ yards; $Y=-6\cdot5$ ft.; $T=8''\cdot040$

Difference

$-15$ yards 0 $-0''\cdot148$

(3) $\alpha=15°$; $\left(\frac{1000}{u_0}\right)^2=1\cdot9004+0\cdot5724=2\cdot4728,$

and by Table X. $u_0=635\cdot92$ f. s.,

and hence $\lambda=0\cdot4269$.

And by Table IX.,

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| $+15°$ | 0·4269 | $+3047$ | $+425·9$ | $+2855$ | |
| $-17°·69$ | „ | $+2818$ | $-431·1$ | $+2995$ | 928·5 |

${}_{15}X_{17·69}=2456$ yards; ${}_{15}Y_{17·69}=-6·5$ ft.; ${}_{15}T_{17·69}=11''·557$; $v'_{17·69}=590$ f.s.

and by Range Table

$X=2467$ yards; $Y=-6·5$ ft.; $T=11''·700$

Difference

$-11$ yards $\quad 0$ „ $\quad -0''·143$

(4) $\alpha=20°$; $\left(\frac{1000}{u_0}\right)^2=2·0077+0·7850=2·7927.$

Hence $u_0=598·39$ f. s.,

and $\lambda=0·378.$

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| $20°$ | 0·378 | 4268 | 819·4 | 3937 | |
| $-24°·2$ | „ | 3863 | $-825·2$ | 4164 | 943 |

${}_{20}X_{24·2}=3015$ yards; ${}_{20}Y_{24·2}=-6·5$ ft.; ${}_{20}T_{24·2}=15''·06$; $v'_{24·2}=564$ f. s.

and by Range Table

$X=3000$ yards; $Y=-6·5$ ft.; $T=15''·20$

Difference

$+15$ yards $\quad 0$ $\quad -0''·14$

(5) $\alpha=25°$; $\left(\frac{1000}{u_0}\right)^2=2·1585+1·0190=3·1775.$

Hence $u_0=561·0$ f. s. and $\lambda=0·332.$

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| $25°$ | 0·332 | 5613 | 1392·9 | 5106 | |
| $-30°·73$ | 0·332 | 4994 | $-1399·6$ | 5443 | 978 |

${}_{25}X_{30·74}=3456$ yards; ${}_{25}Y_{30·74}=-6·5$ ft.; ${}_{25}T_{30·74}=18''·383$; $v'_{30·74}=549$ f. s.

By Range Table

$X=3467$ yards; $Y=-6·5$ ft.; $T=18''·530$

Difference

$-11$ yards $\quad 0$ $\quad -0''·147$

(6) $\alpha = 30°$; $\left(\frac{1000}{u_0}\right)^2 = 2{\cdot}3641 + 1{\cdot}2834 = 3{\cdot}6475.$

Hence $u_0 = 523{\cdot}6$ f. s.; and $\lambda = 0{\cdot}2894$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| 30° | 0·2894 | 7083 | 2192·0 | 6381 | |
| −37°·05 | „ | 6226 | −2199·6 | 6845 | 1032 |

therefore

$_{30}X_{37\cdot05} = 3778$ yards; $_{30}Y_{37\cdot05} = -6{\cdot}5$ ft.; $_{30}T_{37\cdot05} = 21''{\cdot}511$; $v'_{37\cdot05} = 540{\cdot}4$ f.s.

By Range Table

| | | | |
|---|---|---|---|
| $X$ = 3813 yards; | $Y$ = −6·5 ft.; | $T$ = | 21″·750 |
| Difference | | | |
| −35 yards; | 0 | | −0″·239 |

(7) $\alpha = 35°$; $\left(\frac{1000}{u_0}\right)^2 = 2{\cdot}6424 + 1{\cdot}5913 = 4{\cdot}2337.$

Hence $u_0 = 486{\cdot}0$ f. s.; and $\lambda = 0{\cdot}2493$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| 35° | 0·2493 | 8744 | 3305·8 | 7802 | |
| −43°·14 | „ | 7607 | −3314·9 | 8429 | 1107·5 |

therefore

$_{35}X_{43\cdot14} = 3999$ yards; $_{35}Y_{43\cdot14} = -6{\cdot}5$ ft.; $_{35}T_{43\cdot14} = 24''{\cdot}505$; $v'_{43\cdot14} = 538$ f.s.

By Range Table

| | | | |
|---|---|---|---|
| $X$ = 4000 yards; | $Y$ = −6·5 ft.; | $T$ = | 24″·90 |
| Difference | | | |
| −1 yard; | 0 | | −0″·395 |

123. We will now give some examples with heavy shot and high muzzle velocities, and for comparison of results we will use the Range Table[1] of Captain H. J. May, R.N., as already stated for elevations up to 4°, the limit of the table. Here the "jump" was found to be 6 minutes. Hence the results obtained by calculation for elevations of 1°, 2°, 3° and 4° must be compared with similar results derived from the Range Table for elevations of 0° 54′, 1° 54′, 2° 54′ and 3° 54′. Here $d = 12$ inches, $w = 714$ lbs.,

[1] Proceedings of the R. A. Inst. 1886, p. 356.

and muzzle velocity = 1892 f. s. The Newtonian Law holds approximately between this velocity and 1300 f. s., where

$$\log \frac{k}{g} = 0{\cdot}64211.$$

The Range &c. are calculated for the horizontal plane passing through the muzzle of the gun.

(1) $\alpha = 1°$; $\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{1891{\cdot}7}\right)^2 + \frac{k}{g}\frac{d^2}{w} Q_1$ by (11)

$= 0{\cdot}27945 + 0{\cdot}03088 = 0{\cdot}31033.$

Hence $u_0 = 1795{\cdot}1$ f.s., and $\lambda = 2{\cdot}851$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| $+1°$ | 2·851 | 184 | 1·6 | 179 | |
| $-1°{\cdot}05$ | „ | 174 | −1·6 | 178 | 951 |

${}_1X_{1\cdot05} = 1195$ yards; ${}_1Y_{1\cdot05} = 0$; ${}_1T_{1\cdot05} = 1''{\cdot}99$; $v'_{1\cdot05} = 1707{\cdot}1$ f.s.

and by Range Table

$X = 1200$ yards; $Y = 0$; $T = 2''{\cdot}01$;

Difference $-5$ yards 0 $-0''{\cdot}02$

(2) $\alpha = 2°$; $\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}27968 + 0{\cdot}06180 = 0{\cdot}34148.$

Hence $u_0 = 1711{\cdot}28$ f.s.; and $\lambda = 2{\cdot}591$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| 2° | 2·591 | 385 | 7·0 | 367 | |
| $-2°{\cdot}25$ | „ | 356·6 | −7·0 | 374 | 912·2 |

${}_2X_{2\cdot25} = 2249$ yards; ${}_2Y_{2\cdot25} = 0$; ${}_2T_{2\cdot25} = 3''{\cdot}939$; $v'_{2\cdot25} = 1561{\cdot}5$ f.s.

and by Range Table

$X = 2267$ yards; $Y = 0$; $T = 3''{\cdot}977$

Difference $-18$ yards 0 $-0''{\cdot}038$

(3) $\alpha = 3°$; $\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}28012 + 0{\cdot}09277 = 0{\cdot}37289.$

Hence $u_0 = 1637{\cdot}6$ f.s.; and $\lambda = 2{\cdot}372$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| $+3°$ | 2·372 | 603 | 16·54 | 561·4 | |
| $-3°{\cdot}57$ | „ | 546·5 | −16·54 | 584·0 | 880·5 |

${}_3X_{3\cdot57} = 3192$ yards; ${}_3Y_{3\cdot57} = 0$; ${}_3T_{3\cdot57} = 5''{\cdot}827$; $v'_{3\cdot57} = 1442$ f.s.

and by Range Table

| | $X$ | $Y$ | $T$ |
|---|---|---|---|
| | 3200 yards; | 0; | 5″·86 |
| Difference | −8 yards | 0 | −0″·033 |

(4) $\alpha = 4°$; $\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}28072 + 0{\cdot}12382 = 0{\cdot}40454.$

Hence $u_0 = 1572{\cdot}2$ f. s.; and $\lambda = 2{\cdot}187$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| + 4° | 2·187 | 835 | 30·9 | 762·6 | |
| − 5°·02 | „ | 743 | −30·9 | 807·7 | 853·3 |

${}_4X_{5\cdot02} = 4039$ yards; ${}_4Y_{5\cdot02} = 0$; ${}_4T_{5\cdot02} = 7″{\cdot}667$; $v'_{5\cdot02} = 1341{\cdot}6$ f. s.

and by Range Table

| | $X$ | $Y$ | $T$ |
|---|---|---|---|
| | 4057 yards; | 0; | 7″·742 |
| Difference | −18 yards | 0 | −0″·075 |

The calculated time of flight over

4057 yds. = time over 4039 + time over 18 yards
= 7″·667 + 0″·040 = 7″·707

which is 0″·035 less than 7″·742 the time given by the Range Table.

124. Using the horizontal muzzle velocities, the following have been found to be the times of flight by the General Tables, for the distances and elevations specified for the 12-inch B. L. gun.

| | Elevations | 0° 54′ | 1° 54′ | 2° 54′ and 3° 54′ |
|---|---|---|---|---|
| By Range Table | Range | 1200 | 2267 | 3200 4057 yards |
| | Time of Flight | 2″·010 | 3″·977 | 5″·860 7″·742 |
| Calculated Time of Flight | | 2″·002 | 3″·967 | 5″·845 7″·715 |
| | Difference | −0″·008 | −0″·010 | −0″·015 −0″·027 |

125. Next we will calculate several rounds for shot fired from the 4-inch B. L. gun and compare the results with those given in the Range Table. Here $d = 4$ inches; $w = 25$ lbs.; muzzle velocity = 1900 f. s. The "jump" is 6 minutes. The range is calculated on

the horizontal plane passing through the muzzle, as we have no information on this point.

(1) $\alpha = 1°$; $\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u_1}\right)^2 + \frac{k}{g}\frac{d^2}{w} Q_1$

$= 0{\cdot}27709 + 0{\cdot}09801 = 0{\cdot}37510.$

Hence $u_0 = 1632{\cdot}8$ f.s. and $\lambda = 7{\cdot}484 = 7{\cdot}5$ nearly.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| $+1°$ | 7·5 | 202 | + 1·9 | 188 | |
| $-1°{\cdot}184$ | „ | 178 | − 1·9 | 191·8 | 875·3 |

and ${}_1X_{1{\cdot}184} = 1049$ yards; ${}_1Y_{1{\cdot}184} = 0$; ${}_1T_{1{\cdot}184} = 1''{\cdot}927$; $v'_{1{\cdot}184} = 1429$ f.s. and by the Range Table

| | $X$ | $Y$ | $T$ |
|---|---|---|---|
| | 1083 yards; | 0; | $1''{\cdot}970$ |
| Difference | − 34 yards | 0 | $-0''{\cdot}043$ |

Where the tabular values of (v) or $(v)$ change rapidly it will be necessary to use formula (19) or (12) when precision is required.

(2) $\alpha = 2°$; $\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}27735 + 0{\cdot}19611 = 0{\cdot}47346.$

Hence $u_0 = 1453{\cdot}3$ f. s. and $\lambda = 5{\cdot}929$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
|---|---|---|---|---|---|
| $+2°$ | 5·929 | 450·7 | 8·61 | 395·4 | |
| $-2°{\cdot}764$ | „ | 380·3 | −8·61 | 427·3 | 799·3 |

and ${}_2X_{2{\cdot}764} = 1817$ yards; ${}_2Y_{2{\cdot}764} = 0$; ${}_2T_{2{\cdot}764} = 3''{\cdot}714$; $v'_{2{\cdot}764} = 1162$ f.s. By Range Table

| | $X$ | $Y$ | $T$ |
|---|---|---|---|
| | 1811 yards; | 0; | $3''{\cdot}72$ |
| Difference | + 6 yards | 0 | $-0''{\cdot}006$ |

(3) $\alpha = 3°$; $\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}27777 + 0{\cdot}29439 = 0{\cdot}57216.$

Hence $u_0 = 1322{\cdot}0$ f.s. and $\lambda = 4{\cdot}906 = 4{\cdot}9$ nearly.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ |
|---|---|---|---|---|
| 3° | 4·9 | 735 | 21·6 | 61·7 |

or ${}_3x_0 = 3991$ feet; ${}_3y_0 = 117{\cdot}3$ feet; ${}_3t_0 = 2''{\cdot}534.$

As the law changes from the Newtonian to the cubic at a velocity of about 1300 f.s. it will be convenient to change the law at the vertex; then

$$\gamma = \frac{K}{g}\frac{d^2}{w}\left(\frac{u_0}{1000}\right)^3 = 3{\cdot}3891 \times 0{\cdot}64 \times (1{\cdot}322)^3 = 5{\cdot}012 = 5{\cdot}0 \text{ nearly.}$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V′) |
|---|---|---|---|---|---|
| $-4°{\cdot}512$ | 5·0 | 59·4 | $-21{\cdot}6$ | 68·3 | 773·9 |

and

$${}_0x_{4\cdot33} = 3227{\cdot}5 \text{ feet}; \quad {}_0y_{4\cdot33} = -117{\cdot}3 \text{ feet}; \quad {}_0t_{4\cdot33} = 2''{\cdot}805.$$

But

$${}_3x_0 = 3991 \text{ feet}; \quad {}_3y_0 = +117{\cdot}3 \text{ feet}; \quad {}_3t_0 = 2''{\cdot}534$$
$${}_3X_{4\cdot33} = 2406 \text{ yards}; \quad {}_3Y_{4\cdot33} = 0 \quad {}_3T_{4\cdot33} = 5''{\cdot}339; \quad v'_{4\cdot33} = 1023 \text{ f.s.}$$

By Range Table

| | | | | | |
|---|---|---|---|---|---|
| $X$ | = 2400 yards; | $Y$ = | 0 | $T$ | = 5″·340 |
| Difference | +6 yards; | | 0 | | − 0″·001 |

The same example may be solved by the use of French Measures,

$$\mathfrak{v} = 1900 \text{ f. s.} = 579{\cdot}11 \text{ m. s.};$$
$$\mathfrak{u} = \mathfrak{v}\cos\phi = 578{\cdot}3 \text{ m. s.};$$
$$d = 4 \text{ in.} = 10{\cdot}16 \text{ c. m.}$$
$$g = 9{\cdot}809 \text{ m. s.}; \quad p = 11{\cdot}34 \text{ kgs.}$$
$$\text{Log}\frac{a^2}{p} = 0{\cdot}95917;$$
$$\text{Log}\,\tau = \text{Log}\frac{534{\cdot}22}{527} = 0{\cdot}00591;$$
$$\text{Log}\frac{k}{g} = 0{\cdot}51518 \text{ (Table XXIX.).}$$

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u_3}\right)^2 + \frac{k}{g}\frac{a^2}{p}\tau Q_3$$
$$= 2{\cdot}9902 + 3{\cdot}1688 = 6{\cdot}1590.$$

Hence $u_0 = 402{\cdot}94$ m. s.

$$\lambda = \frac{k}{g}\frac{a^2}{p}\tau\left(\frac{u_0}{1000}\right)^2 = 4{\cdot}906 = 4{\cdot}9 \text{ nearly.}$$

$$\text{Log}\frac{1}{g} = 9{\cdot}00838$$
$$\text{Log}\,u_0 = 2{\cdot}60525$$
$$\text{Log}\frac{u_0}{g} = 1{\cdot}61363$$
$$\text{Log}\frac{u_0^2}{g} = 4{\cdot}21888$$

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ |
|---|---|---|---|---|
| 3° | 4·9 | 735 | 21·6 | 617 |

gives $_3x_0 = 1216{\cdot}6$ m.; $_3y_0 = 35{\cdot}76$ m.; $_3t_0 = 2''{\cdot}535$.

The law of Resistance changes to the cubic law at the vertex, and

$$\gamma = 5{\cdot}011 = 5{\cdot}0 \text{ nearly.}$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V′) |
|---|---|---|---|---|---|
| −4°·51 | 5·0 | 594 | −21·6 | 682·5 | 774·2 |

gives

$_0x_{4\cdot51} =$ 983·3 m.; $_0y_{4\cdot51} = -35{\cdot}76$ m.; $_0t_{4\cdot51} = 2''{\cdot}804$; $v'_{4\cdot51} = 312$ m.s.

But

$_3x_0 = 1216{\cdot}6$ m.; $_3y_0 = +35{\cdot}76$ m.; $_3t_0 = 2''{\cdot}535$

$_3X_{4\cdot51} = 2199{\cdot}9$ m.; $_3Y_{4\cdot51} = 0$ $_3T_{4\cdot51} = 5''{\cdot}339$; $v'_{4\cdot51} = 1023{\cdot}6$ f.s.

= 2406 yards;

By Range Table

$X =$ 2400 yards; $Y =$ 0 $T = 5''{\cdot}340$

Difference

+6 yards; 0 $-0''{\cdot}001$

(4) $\alpha = 4°$; $\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}27836 + 0{\cdot}39293 = 0{\cdot}67129.$

Hence $u_0 = 1220{\cdot}6$ and $\lambda = 4{\cdot}182$.

The Newtonian Law holds up to a velocity of 1300 f. s. To find the value of $\phi$ corresponding approximately to this velocity we have $(v) = 10^3 v \div u_0 = 1300 \div 1{\cdot}22056 = 1064$. From the table it will be found that $\phi = +1°$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| +4° | 4·182 | 1052·0 | 42·1 | 850·5 | |
| +1° | „ | 188·4 | 1·7 | 181·4 | 1082 |
| | | 863·6 | 40·4 | 669·1 | |

$_4x_1 =$ 3997 ft.; $_4y_1 = 187{\cdot}0$ ft.; $_4t_1 = 2''{\cdot}537$; $v_1 = 1321$ f. s.

$$\left(\frac{1000}{u_1}\right)^2 = \left(\frac{1000}{u_0}\right)^2 - \frac{k}{g}\frac{d^2}{w} Q_1 = 0{\cdot}67129 - 0{\cdot}09801 = 0{\cdot}57328.$$

Hence $u_1 = 1320{\cdot}7$ f. s.

We must now use the cubic law

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u_1}\right)^3 + \frac{K}{g}\frac{d^2}{w}P_1$$

$$= 0{\cdot}4341 + 0{\cdot}1136 = 0{\cdot}5477.$$

Hence $u_0 = 1222{\cdot}3$ f. s. and $\gamma = 3{\cdot}961 = 4{\cdot}0$ nearly.

This law is to continue till the velocity is reduced to 1050 f.s. Now

$$(v) = 10^3 \times 1050 \div 1222{\cdot}3 = 859,$$

which on referring to the table for $\gamma = 4{\cdot}0$ will give $\phi = -3°$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| +1° | 4·0 | 188 | + 1·7 | 181 | |
| −3° | | 442 | − 10·9 | 481 | 851 |
| | | 630 | − 9·2 | 662 | |

$${}_1x_2 = 2924 \text{ ft.}; \quad {}_1y_2 = -42{\cdot}72 \text{ ft.}; \quad {}_1t_2 = 2''{\cdot}514; \quad v'_2 = 1040{\cdot}1 \text{ f. s.}$$

The law still remains the cubic as before but with reduced coefficient of resistance. The shot has to fall

$$187{\cdot}0 - 42{\cdot}72 = 144{\cdot}28 \text{ ft. vertically.}$$

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u'_2}\right)^3 - \frac{K}{g}\frac{d^2}{w}P_2 = 0{\cdot}8890 - 0{\cdot}2303 = 0{\cdot}6587,$$

which gives $u_0 = 1149{\cdot}3$ and $\gamma = 2{\cdot}221$.

The required value of $(y)$ is

$$10^4 \times 144{\cdot}28 \div \frac{u_0^2}{g} = 35{\cdot}16$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) |
|---|---|---|---|---|
| − 3° | 2·221 | 472·6 | − 11·99 | 497·8 |
| | | | − 35·16 | |
| | | | − 47·15 | |

| | $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V′) |
|---|---|---|---|---|---|---|
| | − 6° | 2·221 | 871·7 | − 43·12 | 955·4 | 842·0 |
| | − 7° | „ | 992·4 | − 56·88 | 1102·2 | 824·8 |
| Hence | − 6° 29 | „ | 906·9 | − 47·15 | 998·0 | 837·0 |
| | − 3° | | 472·6 | − 11·99 | 497·8 | |

$_3x_{6\cdot29} = 1782$ ft.; $_2y_{6\cdot29} = -144{\cdot}22$ ft.; $_2t_{6\cdot29} = 1''{\cdot}786$; $v'_{6\cdot29} = 962$ f. s.

$_1x_3 = 2924$ ft.; $_1y_3 = -42{\cdot}72$ ft.; $_1t_3 = 2''{\cdot}514$

$_4x_1 = 3997$ ft.; $_4y_1 = +187{\cdot}00$ ft.; $_4t_1 = 2''{\cdot}537$

$_4X_{6\cdot29} = 8703$ ft.; $_4Y_{6\cdot29} = +0{\cdot}06$ ft.; $_4T_{6\cdot29} = 6''{\cdot}837$

$= 2901$ yards

By Range Table

$X = 2917$ yards; $Y = 0$; $T = 6''{\cdot}93$

Difference

$-16$ yards $+0{\cdot}06$ ft. $-0''{\cdot}09$

$$\left(\frac{1000}{u'_{6\cdot29}}\right)^2 = 0{\cdot}6587 + 0{\cdot}4858 = 1{\cdot}1445$$

gives $u'_{6\cdot29} = 956{\cdot}0$ f. s. $= 318{\cdot}7$ y. s.

(5) $\alpha = 5°$; $\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}27915 + 0{\cdot}49184 = 0{\cdot}77099$.

Hence $u_0 = 1138{\cdot}88$ f. s. and $\lambda = 3{\cdot}641$.

To find where this law must be discontinued, we have

$$(v) = 10^3 v_\phi \div u_0 = 1300 \div 1{\cdot}13888 = 1140,$$

which gives $\phi = +2°$ nearly.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| $+5°$ | 3·641 | 1394 | 71·10 | 1092·4 | |
| $+2°$ | ,, | 403 | 7·37 | 374·7 | 1158·7 |
| | | 991 | 63·73 | 717·7 | |

$_3x_2 = 3993$ ft.; $_3y_2 = 256{\cdot}8$ ft.; $_3t_2 = 2''{\cdot}539$; $v_2 = 1320$ f. s.

$$\left(\frac{1000}{u_2}\right)^2 = \left(\frac{1000}{u_0}\right)^2 - \frac{k}{g}\frac{d^2}{w}Q_2 = 0{\cdot}77099 - 0{\cdot}19611 = 0{\cdot}57488.$$

Hence $u_2 = 1319{\cdot}0$ f. s.

Here we change to the cubic law.

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u_2}\right)^3 + \frac{K}{g}\frac{d^2}{w}P_2 \text{ by equation (18)}$$

$$= 0{\cdot}4358 + 0{\cdot}2273 = 0{\cdot}6631 \text{ by Table XVII.}$$

Hence $u_0 = 1146{\cdot}8$ f. s., and $\gamma = 3{\cdot}271$ by equation (17).

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | |
|---|---|---|---|---|---|
| 2° | 3·271 | 399 | 7·3 | 373 | by Table XVI. |

which give

$${}_2x_0 = 1632{\cdot}0 \text{ feet}; \quad {}_2y_0 = 29{\cdot}8 \text{ feet}; \quad {}_2t_0 = 1''{\cdot}329$$

But ${}_5x_2 = \underline{3993{\cdot}0}$ „ ; ${}_5y_2 = \underline{256{\cdot}8}$ „ ; ${}_5t_2 = \underline{2''{\cdot}539}$

Therefore

$${}_5x_0 = 5625{\cdot}0 \quad \text{„} \; ; \quad {}_5y_0 = 286{\cdot}6 \quad \text{„} \; ; \quad {}_5t_0 = 3''{\cdot}868.$$

The cubic law ends when

$$(\text{v}) = 10^3 v_\phi \div u_0 = 1100 \div 1{\cdot}147 = 959, \text{ which gives } \phi = -1°.$$

| | $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|---|
| and | −1° | 3·271 | 165·6 | −1·4 | 170 | 950 |

give

$${}_0x_1 = 676{\cdot}5 \text{ feet}; \quad {}_0y_1 = -5{\cdot}72 \text{ feet}; \quad {}_0t_1 = 0''{\cdot}605; \quad v'_1 = 1088{\cdot}1.$$

To find $u'_1$ more correctly, we have

$$\left(\frac{1000}{u'_1}\right)^3 = 0{\cdot}6631 + 0{\cdot}1136 = 0{\cdot}7767.$$

Hence $$u'_1 = 1087{\cdot}9 \text{ f. s.}$$

To find $\phi$ where the velocity is *approximately* 1000 f. s., we have

$$(\text{v}') = 10^3 v_\phi \div u_0 = 1000 \div 1{\cdot}1468 = 872,$$

and the Table for $\gamma = 3{\cdot}271$ gives $\phi = -3°$.

The resistance of the air $\propto v^6$ for velocities 1100 to 1000 f. s.

$$\left(\frac{1000}{u'_2}\right)^6 = \left(\frac{1000}{u'_1}\right)^6 + \frac{L}{g}\frac{d^2}{w}(W_2 - W_1) \text{ by equation (24)}$$

$$= 0{\cdot}6031 + 0{\cdot}3221 = 0{\cdot}9252 \text{ by Table XIX.}$$

which gives $u'_2 = 1013{\cdot}0$ f. s.

As we have no Tables calculated to give the values of $x$, $y$, and $t$ for a resistance varying as the 6th power of the velocity, we must use the Tables already calculated. We will use the Cubic Law and then we have

$$\frac{K}{g}\frac{d^2}{w}(P_2 - P_1) = \left(\frac{1000}{u'_2}\right)^3 - \left(\frac{1000}{u'_1}\right)^3 = \left(\frac{1000}{1013{\cdot}0}\right)^3 - \left(\frac{1000}{1087{\cdot}9}\right)^3,$$

which gives $$\frac{K}{g}\frac{d^2}{w} = \frac{1854}{1050}.$$

Therefore $u_0 = 1134{\cdot}9$ and $\gamma = 2{\cdot}581$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V′) |
|---|---|---|---|---|---|
| $-1°$ | 2·581 | 167 | − 1·4 | 171 | |
| $-3°$ | „ | 466 | − 11·7 | 494 | 894 |

give

$${}_1x_2 = 1196{\cdot}4 \text{ ft.}; \quad {}_1y_2 = -41{\cdot}21 \text{ ft.}; \quad {}_1t_2 = 1''{\cdot}139; \quad v'_2 = 1014{\cdot}6 \text{ f. s.}$$

The cubic law with a reduced coefficient holds now to the end of the range

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u'_2}\right)^3 - \frac{K}{g}\frac{d^2}{w}P_2 = 0{\cdot}9620 - 0{\cdot}2303 = 0{\cdot}7317.$$

This gives $u_0 = 1109{\cdot}8$ f. s. and $\gamma = 2{\cdot}0$.

The shot has to fall a vertical height

$$= 286{\cdot}6 - 5{\cdot}72 - 41{\cdot}21 = 239{\cdot}67 \text{ feet},$$

and $$10^4 \times 239{\cdot}67 \div \frac{u_0^2}{g} = 62{\cdot}66.$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| $-3°$ | 2·0 | 477 | − 12·1 | 500 | |
| $-8°{\cdot}04$ | „ | 1135 | − 74·76 | 1264 | 822·4 |

$${}_2x_{8\cdot04} = 2517{\cdot}3 \text{ ft.}; \quad {}_2y_{8\cdot04} = -239{\cdot}7 \text{ ft.}; \quad {}_2t_{8\cdot04} = 2''{\cdot}634; \quad v'_{8\cdot04} = 912{\cdot}6 \text{ f. s.}$$

$${}_1x_2 = 1196{\cdot}4 \text{ „} \quad {}_1y_2 = -41{\cdot}2 \text{ ft.}; \quad {}_1t_2 = 1''{\cdot}139$$

$${}_0x_1 = 676{\cdot}5 \text{ „} \quad {}_0y_1 = -5{\cdot}7 \text{ ft.}; \quad {}_0t_1 = 0''{\cdot}605$$

$${}_0x_{8\cdot04} = 4390{\cdot}2 \text{ „} \quad {}_0y_{8\cdot04} = -286{\cdot}6 \text{ ft.}; \quad {}_0t_{8\cdot04} = 4''{\cdot}378$$

$${}_5x_0 = 5623{\cdot}0 \text{ „} \quad {}_5y_0 = +286{\cdot}6 \text{ ft.}; \quad {}_5t_0 = 3''{\cdot}865$$

$${}_5X_{8\cdot04} = 3338 \text{ yds.}; \quad {}_5Y_{8\cdot04} = 0 \quad {}_5T_{8\cdot04} \; 8''{\cdot}243$$

By Range Table

$$X = 3392 \text{ yds.}; \quad Y = 0 \quad T = 8''{\cdot}440$$

Difference

$$-54 \text{ yards} \qquad 0 \qquad -0''{\cdot}197$$

In this descending branch we might have neglected to introduce the law of resistance $\propto v^6$ from $v = 1100$ to 1000 f. s. and instead of that changed the coefficient of the cubic law at the velocity 1050 f. s. We must on this supposition make the change at $\phi = -2°$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| $-2°$ | 3·271 | 315·3 | $-5·36$ | 331·6 | 907 |

gives ${}_0x_2 = 1288$ ft.; ${}_0y_2 = -21·9$ ft.; ${}_0t_2 = 1''·181$; $v'_2 = 1040·1$.

$$\left(\frac{1000}{u'_2}\right)^3 = \left(\frac{1000}{u_0}\right)^3 + \frac{K}{g}\frac{d^2}{w}P_2 = 0·6631 + 0·2273 = 0·8904$$

gives $u'_2 = 1039·5$ f. s.

For the remainder of the trajectory we use

$$\log \frac{K}{g} = 0·35915,$$

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u'_2}\right)^3 - \frac{K}{g}\frac{d^2}{w}P_2 = 0·8904 - 0·1534 = 0·7370$$

gives $u_0 = 1107·1$ f. s. and $\gamma = 1·985 = 2·0$ nearly.

The vertical height of the shot when $\phi = -2°$ is

$$286·6 - 21·9 = 264·7 \text{ feet},$$

which gives $(Y') = 10^4 \times 264·7 \div \frac{u_0^2}{g} = 69·5$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V′) |
|---|---|---|---|---|---|
| $-2°$ | 2°0 | 327 | $-5·6$ | 338 | |
| $-8°·06$ | ,, | 1137 | $-75·1$ | 1267 | 822 |

give

| | | | |
|---|---|---|---|
| ${}_2x_{8·06} = 3084·0$ ft.; | ${}_2y_{8·06} = -264·61$ ft.; | ${}_2t_{8·06} = 3''·195$; | $v'_{8·06} = 910·0$ f. s. |
| ${}_0x_2 = 1288$ ft.; | ${}_0y_2 = -21·9$ ft.; | ${}_0t_2 = 1''·181$ | |
| ${}_0x_{8·06} = 4372$ ft.; | ${}_0y_{8·06} = -286·5$ ft.; | ${}_0t_{8·06} = 4''·376$ | |
| ${}_5x_0 = 5625$ ft.; | ${}_5y_0 = +286·6$ ft.; | ${}_5t_0 = 3''·865$ | |
| ${}_4X_{8·06} = 3332$ yards; | ${}_5Y_{8·06} = +0·1$ ft.; | ${}_5T_{8·06} = 8''·243$ | |

By Range Table

$X = 3392$ yards; $Y = 0·0$ ft.; $T = 8''·44$

Difference

$= -60$ yards $= +0·1$ ft. $-0''·197$

126. The General Tables have also been used to calculate the times of flight over the ranges given by the Range Table for the following elevations of the 4-inch B.L. gun.

| Elevation | 0°. 54′ | 1°. 54′ | 2°. 54′ | 3°. 54′ | 4°. 54′ |
|---|---|---|---|---|---|
| Range Table. Ranges | 1083 | 1811 | 2400 | 2917 | 3392 yds. |
| „ „ Times of Flight | 1″·97 | 3″·72 | 5″·34 | 6″·93 | 8″·44 |
| Calculated Time of Flight ... | 1″·997 | 3″·704 | 5″·336 | 6″·909 | 8″·459 |
| Difference | +0″·027 | −0″·016 | −0″·004 | −0″·021 | +0″·019 |

The close agreement between calculation and experiment for ranges up to near two miles affords conclusive evidence of the correctness of the coefficients of resistance adopted.

127. Taking now the 4-inch B.L. gun of 13½ cwt. fired at an elevation of 10° with a muzzle-velocity of 1180 f. s.

$$d = 4 \text{ inches}; \quad w = 25 \text{ lbs.}; \quad \text{“jump”} = 6 \text{ minutes},$$

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u_{10}}\right)^3 + \frac{K}{g}\frac{d^2}{w}P_{10}$$

$$= 0{\cdot}6372 + 1{\cdot}1593 = 1{\cdot}7965.$$

Hence $u_0 = 822{\cdot}6$ f. s. and $\gamma = 1{\cdot}207$.

We will neglect the consideration of the resistance varying as $v^6$ between the velocities 1100 and 1000 f. s., and suppose that a sudden change takes place at 1050 f. s. at which velocity the value of $\log \frac{K}{g}$ falls from 0·53009 to 0·35915, but the cubic law holds on both above and below that velocity.

Here $10^3 v_\phi \div u_0 = 10^3 \times 1050 \div 822{\cdot}6 = 1276,$

which gives $\phi = 8°,$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| 10° | 1·207 | 2391 | 234·5 | 2043 | |
| 8° | „ | 1750 | 132·7 | 1565 | 1283 |
| or 10° to 8° | | 641 | 101·8 | 478 | |

$${}_{10}x_8 = 1347{\cdot}4 \text{ ft.}; \quad {}_{10}y_8 = 214{\cdot}0 \text{ ft.}; \quad {}_{10}t_8 = 1″{\cdot}222; \quad v_8 = 1055{\cdot}4 \text{ f. s.}$$

$$\left(\frac{1000}{u_8}\right)^3 = 1{\cdot}7965 - 0{\cdot}9206 = 0{\cdot}8759.$$

Hence $u_8 = 1045{\cdot}16$ f. s.

We now use the value

$$\frac{K}{g} = 0{\cdot}35915,$$

$$\left(\frac{1000}{u_0}\right)^2 = 0{\cdot}8759 + 0{\cdot}6210 = 1{\cdot}4969.$$

Hence $u_0 = 874{\cdot}18$ f. s. and $\gamma = 0{\cdot}9775$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| 8° | 0·9775 | 1662 | 123·7 | 1526 | 1208 |

${}_8x_0 = 3945{\cdot}5$ ft.; ${}_8y_0 = 293{\cdot}7$ ft.; ${}_8t_0 = 4''{\cdot}144$; $v_8 = 1056$ f. s.

But

${}_{10}x_8 = 1347{\cdot}4$ „ ${}_{10}y_8 = 214{\cdot}0$ „ ${}_{10}t_8 = 1''{\cdot}222$

therefore

${}_{10}x_0 = 5292{\cdot}9$ „ ${}_{10}y_0 = 507{\cdot}7$ „ ${}_{10}t_0 = 5''{\cdot}366$

The law changes at the velocity 820 f. s. Now

$$10^2 \times v_\phi \div u_0 = 10^2 \times 820 \div 874{\cdot}18 = 938 = (Y),$$

which gives $\phi = -4°$. We must therefore continue the same law to $-4°$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V′) |
|---|---|---|---|---|---|
| −4° | 0·9775 | 656 | −22·45 | 677·5 | 942 |

therefore

${}_0x_4 = 1557{\cdot}3$ ft.; ${}_0y_4 = 53{\cdot}3$ ft.; ${}_0t_4 = 1''{\cdot}840$; $v'_4 = 823{\cdot}5$ f. s.

$$\left(\frac{1000}{u'_4}\right)^2 = 1{\cdot}4969 + 0{\cdot}3075 = 1{\cdot}8044,$$

which gives $u'_4 = 821{\cdot}42$ f. s.

We now pass to the Newtonian Law.

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u'_4}\right)^2 - \frac{k}{g}\frac{d^2}{w}Q_4$$

$$= 1{\cdot}4821 - 0{\cdot}1684 = 1{\cdot}3137.$$

Hence $u_0 = 872{\cdot}47$ f. s. and $\lambda = 0{\cdot}9156$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| −13°·19 | 0·9156 | 1949 | −214·8 | 2134 | 858 |
| −4°·00 | „ | 658 | −22·6 | 678 | |
| −4° to −13°·19 | | 1291 | −192·2 | 1456 | |

$_4x_{13\cdot19}=3052\cdot8$ ft.; $_4y_{13\cdot19}=-454\cdot5$ ft.; $_4t_{13\cdot19}=3''\cdot946$; $v'_{13\cdot19}=748$ f.s.
$_0x_4=1557\cdot3$ „ $_0y_4=-53\cdot3$ „ $_0t_4=1''\cdot840$

therefore

$_0x_{13\cdot19}=4610\cdot1$ „ $_0y_{13\cdot19}=-507\cdot8$ „ $_0t_{13\cdot19}=5''\cdot786$.

But

$_{10}x_0=5292\cdot9$ „ $_{10}y_0=+507\cdot7$ „ $_{10}t_0=5''\cdot366$

Hence

$_{10}X_{13\cdot19}=3301$ yards; $_{10}Y_{13\cdot19}=-0\cdot1$ „ $_{10}T_{13\cdot19}=11''\cdot152$

by Range Table

$X=3414$ yards; $Y=0\cdot0$; $T=11''\cdot43$

Difference

$-113$ yards $-0\cdot1$ „ $-0''\cdot278$

128. We will now calculate the range, &c. of the 4-inch B.L. gun fired at an elevation of 15°, taking into account the variation in the density of the air, supposing that at the gun the readings of the barometer and thermometer were respectively 30 inches and 67° F. Referring to Table XX, we find the corresponding value of $\log\tau$ to be 9·9935. This corresponds to a height 5100 feet in Table XXI. It will be found by trial that the rise for the arc 1900 to 1300 f.s. is about 1000 feet, or the mean height would be 500 feet, which added to 5100 feet equals 5600 feet, which gives $\log\tau=9\cdot9856$ by Table XXI. Muzzle velocity 1900 f.s. as before.

$$\left(\frac{1000}{u_0}\right)^2=\left(\frac{1000}{1835\cdot2}\right)^2+\frac{k}{g}\frac{d^2}{w}\tau Q_{15}=0\cdot2969+1\cdot4726=1\cdot7695,$$

which gives $u_0=751\cdot75$ f.s. and $\lambda=1\cdot535$.

The law of resistance changes at the velocity 1300 f.s. To find the corresponding value of $\phi$ we have $(v)=1000v_\phi\div u_0=1730$, which gives $\phi=12°$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| 15° | 1·535 | 5749 | 989·8 | 3798 | |
| 12° | „ | 3460 | 432·2 | 2680 | 1749 |

$_{15}x_{12}=4018$ feet; $_{15}y_{12}=978\cdot9$ feet; $_{15}t_{12}=2''\cdot611$; $v_{12}=1314\cdot8$.

$$\left(\frac{1000}{u_{12}}\right)^2=\left(\frac{1000}{u_0}\right)^2-\frac{k}{g}\frac{d^2}{w}\tau Q_{12}=1\cdot7695-1\cdot1631=0\cdot6064,$$

which gives $u_{12}=1284\cdot22$ f.s.

We will omit the law of resistance varying as $v^6$ and suppose the cubic law extends from 1300 to 1050 f.s. Using the above law we may find approximately the value of $\phi$ corresponding to 1050 f.s. for $(v) = 1000 \times 1050 \div 751{\cdot}75 = 1396$, which gives $\phi = 8°$. Then $({}^{12}y^8) = 432{\cdot}2 - 141{\cdot}5$ gives approximately ${}_{12}y_8 = 510$ feet. And $5100 + 979 + \frac{1}{2}510 = 6334$ feet gives $\log \tau = 9{\cdot}9741$ by Table XXI. From $\phi = 12°$ to $\phi = 8°$ the cubic law holds and $\log \frac{K}{g} = 0{\cdot}53009$ by Table IV. And

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u_{12}}\right)^3 + \frac{K}{g}\frac{d^2}{w}\tau P_{12} = 0{\cdot}4722 + 1{\cdot}3227 = 1{\cdot}7949,$$

which gives $u_0 = 822{\cdot}82$ f.s. and $\gamma = 1{\cdot}139$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| 12° | 1·139 | 3104 | 377·5 | 2548 | |
| 8° | „ | 1723 | 129·9 | 1553 | 1259 |

${}_{12}x_8 = 2905$ feet; ${}_{12}y_8 = 520{\cdot}8$ feet; ${}_{12}t_8 = 2''{\cdot}543$; $v_8 = 1036$ f.s.,

$$\left(\frac{1000}{u_8}\right)^3 = \left(\frac{1000}{u_0}\right)^3 - \frac{K}{g}\frac{d^2}{w}\tau P_8 = 1{\cdot}7949 - 0{\cdot}8672 = 0{\cdot}9277,$$

which gives $u_8 = 1025{\cdot}4$ f.s.

Suppose the above law to hold up to $\phi = 0$, the shot has to rise $129{\cdot}9 \times 10^{-4} \times (u_0^2 \div g) = 273$ feet. Now

$$5100 + 979 + 521 + \tfrac{1}{2}273 = 6737 \text{ feet},$$

which gives $\log \tau = 9{\cdot}9678$ approximately for next arc.

The cubic law of resistance still holds but the coefficient is reduced to $\log \frac{K}{g} = 0{\cdot}35915$.

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u_8}\right)^3 + \frac{K}{g}\frac{d^2}{w}\tau P_8 = 0{\cdot}9277 + 0{\cdot}5766 = 1{\cdot}5043,$$

$$\therefore\ u_0 = 872{\cdot}75 \text{ f.s. and } \gamma = 0{\cdot}9032 = 0{\cdot}9 \text{ nearly.}$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| 8° | 0·9 | 1635 | 121·0 | 1514 | 1186 |

or ${}_8x_0 = 3869$ ft.; ${}_8y_0 = 286{\cdot}3$ ft.; ${}_8t_0 = 4''{\cdot}105$, $v_8 = 1035{\cdot}1$ f.s.

${}_{12}x_8 = 2905$ ft.; ${}_{12}y_8 = 520{\cdot}8$ ft.; ${}_{12}t_8 = 2''{\cdot}543$

${}_{15}x_{12} = 4018$ ft.; ${}_{15}y_{12} = 978{\cdot}9$ ft.; ${}_{15}t_{12} = 2''{\cdot}611$

${}_{15}x_0 = 10792$ ft.; ${}_{15}y_0 = 1786{\cdot}0$ ft.; ${}_{15}t_0 = 9''{\cdot}259$

The law changes at the velocity 820 f. s. and

$$1000 \times 820 \div u_0 = 940,$$

which gives $\phi = -5°$ and $(y) = 34{\cdot}8$, so that $34{\cdot}8 \div 10^4 \times u_0^2 \div g = 82{\cdot}35$ feet. So that the mean height for the next arc will approximately be $5100 + 1786 - \frac{1}{2}82 = 6845$ feet, which gives $\log \tau = 9{\cdot}9661$. This gives $\gamma = 0{\cdot}900$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| $-5°$ | 0·9 | 814 | $-34{\cdot}8$ | 844 | 935 |

$$\therefore {}_0x_5 = 1926 \text{ ft.}, \quad {}_0y_5 = -82{\cdot}3 \text{ ft.}, \quad {}_0t_5 = 2''{\cdot}288, \quad v'_5 = 816 \text{ f. s.},$$

$$\left(\frac{1000}{u'_5}\right)^2 = \left(\frac{1000}{u_0}\right)^2 + \frac{K}{g}\frac{d^2}{w}\tau P_5 = 1{\cdot}5043 + 0{\cdot}3561 = 1{\cdot}8604,$$

$$\therefore u'_5 = 813{\cdot}07 \text{ f. s.}$$

The law now changes to the Newtonian, where $\log \frac{k}{g} = 0{\cdot}27402$, and the mean height of the shot is $5100 + \frac{1}{2}(1716 - 82) = 5952$ which gives $\log \tau = 9{\cdot}9801$.

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u'_5}\right)^2 + \frac{k}{g}\frac{d^2}{w}\tau Q_5 = 1{\cdot}5126 - 0{\cdot}2013 = 1{\cdot}3113,$$

$$\therefore u_0 = 873{\cdot}27 \text{ f. s. and } \lambda = 0{\cdot}8762.$$

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| $-5°$ | 0·8762 | 814 | $-34{\cdot}8$ | 844 | |
| $-25{\cdot}77$ | ,, | 3486 | $-754{\cdot}1$ | 4085 | 811 |
| | | ${}_5x_{25\cdot77} = 6330$ feet; | ${}_5y_{25\cdot77} = -1703{\cdot}9$ feet; | ${}_5t_{25\cdot77} = 8''{\cdot}792$ | $v'_{25\cdot77} = 708{\cdot}2$ f.s. |
| | | ${}_0x_5 = 1926$ feet; | ${}_0y_5 = -82{\cdot}3$ feet; | ${}_0t_5 = 2''{\cdot}288$ | $u'_{25\cdot77} = 637{\cdot}0$ |
| | | ${}_0x_{25\cdot77} = 8256$ feet; | ${}_0y_{25\cdot77} = -1786{\cdot}2$ feet; | ${}_0t_{25\cdot77} = 11''{\cdot}080$ | |
| | | ${}_{15}x_0 = 10792$ feet; | ${}_{15}y_0 = +1786{\cdot}0$ feet; | ${}_{15}t_0 = 9''{\cdot}259$ | |
| | | ${}_{15}X_{25\cdot77} = 6349$ yards; | ${}_{15}Y_{25\cdot77} = -0{\cdot}2$ feet; | ${}_{15}T_{25\cdot77} = 20''{\cdot}339$ | |
| By Range Table | $X$ | $= 6608$ yards; | $Y = 0$ | $T = 21''{\cdot}340$ | |
| Difference | | $-259$ yards | $-0{\cdot}2$ feet | $-1''{\cdot}001$ | |

129. I have calculated the preceding example according to the laws of resistance given in Table IV, from which I obtained the following results.

Ascending Branch.

$$
\begin{array}{lll}
{}_{15}x_{12} = 3982 \text{ feet}; & {}_{15}y_{12} = 970{\cdot}1 \text{ feet}; & {}_{15}t_{12} = 2''{\cdot}600 \\
{}_{12}x_{9} = 2253 \text{ feet}; & {}_{12}y_{9} = 418{\cdot}8 \text{ fect}; & {}_{12}t_{9} = 1''{\cdot}928 \\
{}_{9}x_{0} = 4425 \text{ feet}; & {}_{9}y_{0} = 373{\cdot}8 \text{ feet}; & {}_{9}t_{0} = 4''{\cdot}660 \\
{}_{15}x_{0} = 10660 \text{ feet}; & {}_{15}y_{0} = 1762{\cdot}7 \text{ feet}; & {}_{15}t_{0} = 9''{\cdot}188
\end{array}
$$

Descending Branch.

$$
\begin{array}{lll}
{}_{0}x_{5} = 1881 \text{ feet}; & {}_{0}y_{5} = -\ 80{\cdot}2 \text{ feet}; & {}_{0}t_{5} = 2''{\cdot}263 \\
{}_{5}x_{26{\cdot}03} = 6205 \text{ feet}; & {}_{5}y_{26{\cdot}03} = -\ 1682{\cdot}9 \text{ feet}; & {}_{5}t_{26{\cdot}03} = 8''{\cdot}768 \\
{}_{0}x_{26{\cdot}03} = 8086 \text{ feet}; & {}_{0}y_{26{\cdot}03} = -\ 1763{\cdot}1 \text{ feet}; & {}_{0}t_{26{\cdot}03} = 11''{\cdot}031 \\
{}_{15}x_{0} = 10660 \text{ feet}; & {}_{15}y_{0} = +\ 1762{\cdot}7 \text{ feet}; & {}_{15}t_{0} = 9''{\cdot}188 \\
{}_{15}X_{26{\cdot}03} = 6249 \text{ yards}; & {}_{15}Y_{26{\cdot}03} = -\ 0{\cdot}4 \text{ feet}; & {}_{15}T_{26{\cdot}03} = 20''{\cdot}219
\end{array}
$$

By Range Table

$$
X = 6608 \text{ yards}; \quad Y = 0 \quad T = 21''{\cdot}340
$$

Difference

$$
-\ 359 \text{ yards} \qquad -\ 0{\cdot}4 \text{ feet} \qquad -\ 1''{\cdot}121
$$

I have also calculated the above example for an ogival head, struck with a radius of two diameters, using $\kappa \frac{d^2}{w} = 0{\cdot}97 \frac{d^2}{w}$ instead of $\frac{d^2}{w}$ throughout, from which I obtained a range 6448 yards.

Where the coefficients of resistance, &c. are correct, the calculated times of flight and range ought to agree with experiment, when the air is still. But a wind might not affect the time of flight sensibly, and yet disturb the range considerably. See a paper by Colonel Maitland, R.A., "On the influence of the wind on the motion of projectiles[1]." My calculated angles of descent and terminal velocities have not been compared with those given in the Range Tables, because as these latter were not measured quantities they afforded no test of the accuracy of my coefficients.

[1] Proceedings of the R. A. Inst. VIII. p. 343.

## *The Jubilee Rounds.*

130. When the "Jubilee" experiment was first spoken of a rough calculation was made by me, neglecting the variation of the density of the air, which gave a range of 16,709 yards for an elevation of 40°, and I then expressed an opinion that the actual range would probably be a mile or two more. But when it was resolved to carry out the experiment, I decided to calculate the range and time of flight by Bernoulli's method, using the values of the coefficients of resistance given in Table IV, and allowing for the variation in the density of the air. The muzzle velocity was supposed to be 2360 f. s.; the diameter of the shot 9·2 inches; its weight 380 lbs.; and the elevation 40°. *The atmosphere was supposed to be undisturbed,* and the force of gravity and the temperature of the air were assumed to be constant. This calculation was made with very great care, and to secure accuracy steps of a single degree were taken from 40° to 30°, and steps of two degrees from 30° to 18°. The range on a horizontal plane passing through the muzzle was thus found to be 19,436 yards and the time of flight 62″·15. These results were communicated to the Ordnance Committee, March 31, 1888. In the following month two rounds were fired at an elevation of 40°, and the ranges obtained were 21,048 and 21,358 yards with a "fresh favorable wind[1]." On this I expressed an opinion to the Ordnance Committee that "the calculated range falls so much below the experimental range *that there must be some error* either in the calculation or in the measurements." The nature of the error was apparent when in the following July two more rounds were fired at an elevation of 40°, which gave ranges of 20,236 and 20,210 yards, being about 1000 yards less than those obtained before. It was also found that the actual muzzle velocity was 2375 f. s. instead of 2360 f. s. which was used in the calculation. The long range obtained in April appeared to be due chiefly to the "fresh favorable wind" which had a much greater effect than was expected.

[1] Proceedings of the R. A. Inst. XVI. p. 491.

But it should be remembered that in the case of a steady wind, its velocity at a height of 16,000 feet would be at least *three times* its velocity on the surface of the earth, and that the wind would be acting upon the shot for at least sixty seconds. The wind, at the time the experiments were made, was generally favourable, but in no case unfavourable to a long range.

131. Afterwards the same data were used with muzzle velocity 2360 f.s. to calculate a complete Range Table for all elevations up to 45°; but the Range, Time of Flight, &c. were calculated for a horizontal plane 27 feet below the muzzle of the gun. *The air was supposed to be at rest.* This Range Table was communicated to the Ordnance Committee, Aug. 7, 1888; and it was published in "Nature" as follows, with the exception of some small corrections for elevations 1° to 4°.

| Elevation | Range | Height of Vertex | Time of Flight | Angle of Descent | Striking Velocity | Horizontal Striking Velocity |
|---|---|---|---|---|---|---|
| o | Yards | Feet | Seconds | o ′ | *f. s.* | *y. s.* |
| 0 | 969 | 0 | 1·3 | 1 4 | 2,154 | 718 |
| 1 | 2,108 | 25 | 3·2 | 1 35 | 1,931 | 643 |
| 2 | 3,419 | 94 | 5·1 | 2 47 | 1,708 | 569 |
| 3 | 4,574 | 201 | 7·3 | 4 14 | 1,534 | 508 |
| 4 | 5,586 | 343 | 9·4 | 5 53 | 1,399 | 464 |
| 5 | 6,475 | 517 | 11·4 | 7 38 | 1,291 | 426 |
| 6 | 7,271 | 716 | 13·4 | 9 30 | 1,200 | 395 |
| 7 | 7,999 | 937 | 15·3 | 11 28 | 1,128 | 368 |
| 8 | 8,669 | 1,180 | 17·1 | 13 28 | 1,075 | 349 |
| 9 | 9,291 | 1,445 | 18·9 | 15 28 | 1,040 | 334 |
| 10 | 9,876 | 1,731 | 20·6 | 17 23 | 1,022 | 325 |
| 11 | 10,430 | 2,036 | 22·3 | 19 9 | 1,015 | 320 |
| 12 | 10,952 | 2,360 | 23·9 | 20 54 | 1,009 | 314 |
| 13 | 11,448 | 2,703 | 25·5 | 22 38 | 1,003 | 309 |
| 14 | 11,922 | 3,065 | 27·0 | 24 21 | 998 | 303 |
| 15 | 12,379 | 3,443 | 28·5 | 26 2 | 993 | 297 |
| 16 | 12,804 | 3,835 | 30·0 | 27 40 | 990 | 292 |
| 17 | 13,217 | 4,242 | 31·5 | 29 15 | 987 | 287 |
| 18 | 13,618 | 4,663 | 33·0 | 30 48 | 985 | 282 |
| 19 | 14,007 | 5,099 | 34·4 | 32 19 | 984 | 277 |
| 20 | 14,385 | 5,550 | 35·9 | 33 48 | 984 | 273 |
| 21 | 14,750 | 6,015 | 37·3 | 35 15 | 985 | 268 |
| 22 | 15,103 | 6,489 | 38·8 | 36 40 | 987 | 264 |
| 23 | 15,445 | 6,970 | 40·2 | 38 3 | 990 | 260 |
| 24 | 15,775 | 7,459 | 41·6 | 39 24 | 993 | 256 |
| 25 | 16,092 | 7,956 | 43·0 | 40 41 | 996 | 252 |
| 26 | 16,398 | 8,461 | 44·4 | 41 54 | 1,000 | 248 |
| 27 | 16,691 | 8,974 | 45·7 | 43 2 | 1,004 | 245 |
| 28 | 16,973 | 9,494 | 47·1 | 44 6 | 1,009 | 242 |
| 29 | 17,242 | 10,022 | 48·4 | 45 7 | 1,014 | 239 |
| 30 | 17,501 | 10,558 | 49·7 | 46 5 | 1,019 | 236 |
| 31 | 17,747 | 11,102 | 51·0 | 47 1 | 1,025 | 233 |
| 32 | 17,981 | 11,654 | 52·2 | 47 56 | 1,031 | 230 |
| 33 | 18,203 | 12,214 | 53·5 | 48 50 | 1,037 | 228 |
| 34 | 18,413 | 12,782 | 54·7 | 49 43 | 1,044 | 225 |
| 35 | 18,612 | 13,357 | 56·0 | 50 35 | 1,051 | 222 |
| 36 | 18,799 | 13,941 | 57·2 | 51 27 | 1,058 | 220 |
| 37 | 18,973 | 14,534 | 58·5 | 52 18 | 1,065 | 217 |
| 38 | 19,136 | 15,136 | 59·7 | 53 8 | 1,072 | 214 |
| 39 | 19,287 | 15,747 | 61·0 | 53 58 | 1,079 | 212 |
| 40 | 19,426 | 16,368 | 62·2 | 54 47 | 1,086 | 209 |
| 41 | 19,553 | 17,001 | 63·4 | 55 36 | 1,092 | 206 |
| 42 | 19,668 | 17,646 | 64·7 | 56 24 | 1,099 | 203 |
| 43 | 19,772 | 18,302 | 65·9 | 57 11 | 1,105 | 200 |
| 44 | 19,864 | 18,969 | 67·1 | 57 57 | 1,111 | 197 |
| 45 | 19,944 | 19,648 | 68·3 | 58 43 | 1,117 | 193 |

"It will be seen that the ranges go on increasing up to an

"elevation of 45°, and would probably go on beyond an elevation "of 50° before reaching a maximum."—"Nature," Sept. 13, 1888, p. 468.

132. In July, 1888, two rounds were fired at an elevation of 30° which gave ranges of 17,500 and 18,344 yards, differing by 844 yards, although the wind appears to have been the same in both cases[1]. Again two rounds fired at an elevation of 35° gave ranges of 18,936 and 19,420 yards, which differ by 484 yards. Four rounds in all were fired at an elevation of 40° which gave ranges of 20,210, 20,236, 21,048 and 21,358 yards; so that the extreme difference of the ranges fired at this elevation was 1148 yards, fully justifying my suspicion of an error in range. A single round was fired at an elevation of 45° which gave a range of 21,800 yards, with a "favorable moderate" wind. This range is plainly far too great. In order to carry out experiments of this kind in a satisfactory manner it would be necessary to select a time when the atmosphere was at rest, and also to *test the state of affairs in the upper regions of the air by sending up trial balloons*[2]. Other experiments might be made to test the effect of the wind blowing both up and down the range. It is clear that no theoretical calculations could agree with the above discordant results of experiment.

133. Taking rounds fired in July, 1888[3], we have

| Elevation | 30° | 35° | 40° | 45° | |
|---|---|---|---|---|---|
| Ranges | 17,500 | 19,420 | 20,236 | 21,800 | yards |
| „ | 18,344 | 18,936 | 20,210 | —— | „ |
| Mean Ranges | 17,922 | 19,178 | 20,223 | 21,800 | |
| Difference of Mean Ranges | 1,256 | 1,045 | 1,577 | yards. | |

We are tolerably certain that as the elevation of the gun approaches 45°, the range must be approaching a maximum in a still atmosphere, and therefore that the difference of ranges corre-

[1] Proceedings of the R. A. Inst. XVI. p. 491.

[2] From experiments on the velocity of the wind on the Eiffel Tower 994 feet above the ground and at the Paris Meteorological Office 66 feet above the ground, the average *velocity* on the tower was found to be 16 miles an hour and that at the Office only 5 miles an hour. *Nature*, Vol. 41, p. 67.

[3] Proceedings of the R. A. Inst. XVI. p. 491.

sponding to every increment of 5° in the elevation must be a *decreasing* quantity, and very different from the results stated above. In order to bring these results into something like order it will be necessary to apply corrections say of – 200 and – 1200 yds. respectively to the above mean ranges for elevations of 40° and 45° to allow for the effect of wind.

| Elevations | 30° | 35° | 40° | 45° |
|---|---|---|---|---|
| Observed Mean Ranges | 17,922 | 19,178 | 20,223 | 21,800 yds. |
| Corrections for Wind | 0? | 0? | – 200 | – 1,200 |
| | 17,922 | 19,178 | 20,023 | 20,600 |
| Differences of Corrected Ranges | 1,256 | 845 | 577 yds. | |
| Calculated Ranges (m.v. 2360 f.s.) | 17,501 | 18,612 | 19,426 | 19,944 |
| Correction for m.v. | + 174 | + 185 | + 193 | + 198 |
| Ranges (m.v. 2375 f.s.) | 17,675 | 18,797 | 19,619 | 20,142 |
| | 1,122 | 822 | 523 | |
| Differences of above Ranges | 247 | 381 | 404 | 458 yds. |
| or Difference per cent. | 1·4 | 2·0 | 2·0 | 2·2 |

These deficiencies in the calculated ranges will be accounted for by the "jump", vertical "drift", wind, more pointed form of shot used in experiment, and perhaps a slight increase of the muzzle velocity due to increased elevation.

134. The calculation of the Range Table for the 9·2-inch wire gun up to an elevation of 45° with a muzzle velocity of 2360 f.s. was undertaken with a view to show the *exact results* given by the coefficients of resistance derived from my experiments with ogival-headed projectiles struck with a radius of 1½ diameter. Any needful allowance can afterwards be made for wind, a more pointed form of projectile, "jump", vertical "drift", &c.; but I have failed to obtain any evidence that my coefficients of resistance require to be reduced, as before explained. I much regret that the times of flight have not been published, because they are not nearly so much affected by the wind as ranges are.

All things considered I submit my calculated range table when there is no wind as a document far more instructive than the results of actual experiment made in windy weather, which was generally favourable to a long range.

135. The following is given as an example of the improved method pursued in the calculation of the Jubilee rounds, but in this case the muzzle velocity is 2375 instead of 2360 f.s., and the diameter of the shot is supposed to be 9·15 instead of 9·2 inches[1]. The elevation of the gun is 40°. Although the resistance of the air varies as the square of the velocity from 2375 to 1300 f.s., it seems desirable to divide the corresponding trajectory into two arcs at least, in order to take account of the decreasing density of the air. Suppose that at the gun the Barometer stands at 30 inches and the Thermometer at 60° F. Table XX. gives $\text{Log}\,\tau = 9{\cdot}9998$. This value is found corresponding to a height 4680 feet in Table XXI. We will suppose that the first arc rises to a height of 7800 feet above the gun. $w = 380$ lbs. Then

$$4680 + \tfrac{1}{2} \times 7800 = 8580 \text{ feet}$$

gives $\log \tau = 9{\cdot}9391$ by Table XXI.

and $\text{Log}\, d^2 \div w = 9{\cdot}34306;$

$$u_{40} = 2375 \cos 40^\circ = 1819{\cdot}3 \text{ f.s.}$$

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u_{40}}\right)^2 + \frac{k}{g}\frac{d^2}{w}\tau Q_{40} = 0{\cdot}30212 + 1{\cdot}56092 = 1{\cdot}86304.$$

This gives $u_0 = 732{\cdot}66$ f.s.; and $\lambda = 0{\cdot}4509$.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| 40° | 0·4509 | 17494 | 9429 | 11726 | 3258 |

We must now find the value of $\phi$ for the upper end of the arc when the shot has risen a height of 7800 feet. Here

$$\{({}^{40}y^0) - ({}^{\phi}y^0)\}\,\frac{u_0^2}{10^4 g} = 7800,$$

or $$({}^{\phi}y^0) = 4751,$$

which gives $\phi = 35^\circ$ nearly by the Table.

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| 35° | 0·4509 | 11499 | 4767 | 8857 | 2159 |

[1] Proceedings of the R. A. Inst. XVI. p. 492.

and therefore

$${}_{40}x_{35} = 9996 \text{ ft.}; \quad {}_{40}y_{35} = 7773{\cdot}6 \text{ ft.}; \quad {}_{40}t_{35} = 6''{\cdot}530; \quad v_{35} = 1581{\cdot}8 \text{ f.s.};$$

$$\text{or} \quad \left(\frac{1000}{u_{35}}\right)^2 = \left(\frac{1000}{u_0}\right)^2 - \frac{k}{g}\frac{d^2}{w}\tau Q_{35} = 1{\cdot}8630 - 1{\cdot}2664 = 0{\cdot}5966;$$

$$\therefore \quad u_{35} = 1294{\cdot}7 \text{ f.s.}$$

The next arc of the trajectory must be made to terminate where the velocity is about 1300 f.s. In order to obtain an approximate value of $\phi$ for this point, we may use the same value of $\log \tau$ as before, then $(v_\phi) = 10^3 \times 1300 \div u_0 = 1774$ and we obtain $\phi = 30°$, and $({}^{35}y^0) - ({}^{30}y^0) = 2063$, which gives ${}_{35}y_{30} = 3440$ feet. But as $\tau$ will be really less than we have supposed we may assume that ${}_{35}y_{30}$ will be 3540 feet. Then

$$4680 + 7774 + \tfrac{1}{2} \times 3540 = 14224 \text{ feet}$$

gives

$$\log \tau = 9{\cdot}8510,$$

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u_{35}}\right)^2 + \frac{k}{g}\frac{d^2}{w}\tau Q_{35} = 0{\cdot}5966 + 1{\cdot}0339 = 1{\cdot}6305;$$

$$\therefore \quad u_0 = 783{\cdot}14 \text{ f.s.}; \text{ and } \lambda = 0{\cdot}4206 = 0{\cdot}42 \text{ nearly.}$$

| $\phi$ | $\lambda$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|---|
| 35° | 0·42 | 10893 | 4435 | 8646 | |
| 30° | „ | 8007 | 2583 | 6765 | 1651 |
| | | ${}_{35}x_{30} =$ 5499 ft. | ${}_{35}y_{30} = 3528{\cdot}5$ ft. | ${}_{35}t_{30} = 4''{\cdot}576$; | $v_{30} = 1293{\cdot}0$ f.s. |

$$\text{Also} \quad \left(\frac{1000}{u_{30}}\right)^2 = \left(\frac{1000}{u_0}\right)^2 - \frac{k}{g}\frac{d^2}{w}\tau Q_{30} = 1{\cdot}6305 - 0{\cdot}8339 = 0{\cdot}7966;$$

$$\therefore \quad u_{30} = 1120{\cdot}4 \text{ f.s.}$$

(3) The cubic law holds from velocity 1300 to 1100 f.s., but as we have no means of calculating $x$, $y$ and $t$ for the case where the resistance varies as the sixth power of the velocity, we will suppose the change in the coefficient of resistance to take place at a velocity near 1050 f.s.

$$(v_\phi) = 10^3 \times 1050 \div u_0 = 1341,$$

which gives $\phi = 22°$, supposing the last arc to be continued so far. But as the resistance will be less than we have supposed it to be, we will next take the arc 30° to 21°, then

$$\{({}^{30}y^0) - ({}^{21}y^0)\} \times \frac{u_0^2}{g} \times 10^{-4} = 3126 \text{ feet.}$$

But as the resistance would be less than we have supposed it we may assume the rise in this arc to be a little more, say 3160 feet. Then $4680 + 7774 + 3529 + \frac{1}{2}\,3160 = 17563$ gives $\log \tau = 9{\cdot}7989$.

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u_{30}}\right)^2 + \frac{K}{g}\frac{d^2}{w}\tau P_{30} = 0{\cdot}71105 + 0{\cdot}90442 = 1{\cdot}61547;$$

$$\therefore\ u_0 = 852{\cdot}25 \text{ f.s. and } \gamma = 0{\cdot}2909.$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| 30° | 0·2909 | 7303 | 2295 | 6474 | |
| 21° | „ | 4389 | 882·6 | 4101 | 1237·7 |

$${}_{30}x_{21} = 6575 \text{ ft.};\ {}_{30}y_{21} = 3186{\cdot}9 \text{ ft.};\ {}_{30}t_{21} = 6''{\cdot}282;\ v_{21} = 1054{\cdot}8 \text{ f.s.}$$

$$\left(\frac{1000}{u_{21}}\right)^2 = \left(\frac{1000}{u_0}\right)^2 - \frac{K}{g}\frac{d^2}{w}\tau P_{21} = 1{\cdot}61457 - 0{\cdot}56777 = 1{\cdot}04770;$$

$$\therefore\ u_{21} = 984{\cdot}6 \text{ f.s.}$$

If we produced the above arc to where $\phi = 0$ the vertex would be reached at a height $= 882{\cdot}6 \times \frac{u_0^2}{g} \div 10^4 = 1991$ feet, or as the resistance will be lower than we have supposed we may assume the height to be 2060 feet. Then

$$4680 + 7774 + 3529 + 3186 + \tfrac{1}{2} \times 2060 = 20199 \text{ feet},$$

which gives $\log \tau = 9{\cdot}7578$.

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u_{21}}\right)^2 + \frac{K}{g}\frac{d^2}{w}\tau P_{21} = 1{\cdot}04770 + 0{\cdot}34844 = 1{\cdot}39614;$$

$$\therefore\ u_0 = 894{\cdot}72 \text{ f.s. and } \gamma = 0{\cdot}2066.$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) |
|---|---|---|---|---|
| 21° | 0·2066 | 4202 | 832·0 | 4015 |
| | | ${}_{21}x_0 = 10450$ ft.; | ${}_{21}y_0 =$ 2069·0 ft.; | ${}_{21}t_0 = 11''{\cdot}160$ |
| But | | ${}_{30}x_{21} =$ 6575 „ ; | ${}_{30}y_{21} =$ 3186·9 „ ; | ${}_{30}t_{21} =$ 6 ·282 |
| | | ${}_{35}x_{30} =$ 5499 „ ; | ${}_{35}y_{30} =$ 3528·5 „ ; | ${}_{35}t_{30} =$ 4 ·576 |
| | | ${}_{40}x_{35} =$ 9996 „ ; | ${}_{40}y_{35} =$ 7773·6 „ ; | ${}_{40}t_{35} =$ 6 ·530 |
| or | | ${}_{40}x_0 = 32520$ ft.; | ${}_{40}y_0 = 16558{\cdot}0$ ft.; | ${}_{40}t_0 = 28$ ·548 |

Suppose the next arc to be taken from $\phi = 0$ to $-20°$.

$$({}^0\text{Y}^{20})\ \frac{u_0^2}{g} \times 10^{-4} = 604{\cdot}2 \times \frac{u_0^2}{g}\,10^{-4} = 1503 \text{ feet.}$$

Then to find $\log \tau$ we have

$$4680 + 16558 - \tfrac{1}{2}1504 = 20486 \text{ feet},$$

which gives $\log \tau = 9{\cdot}7534$ by Table XXI.;

$$\therefore\ \gamma = 0{\cdot}2045;\ \text{and}\ u_0 = 894{\cdot}22 \text{ f.s. as before.}$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| $-20°$ | 0·2045 | 3393 | − 603·3 | 3514 | 992·7 |

$${}_0x_{20} = 8438 \text{ ft.};\ {}_0y_{20} = -1500{\cdot}3 \text{ ft.};\ {}_0t_{20} = 9''{\cdot}767;\ v'_{20} = 888{\cdot}2 \text{ f.s.}$$

$$\left(\frac{1000}{u'_{20}}\right)^2 = \left(\frac{1000}{u_0}\right)^2 + \frac{K}{g}\frac{d^2}{w}\tau P_{20} = 1{\cdot}39614 + 0{\cdot}32551 = 1{\cdot}72165;$$

$$\therefore\ u'_{20} = 834{\cdot}35 \text{ f.s.}$$

Assuming that the same law holds for the next arc $-20°$ to $-40°$,

$$({}^{20}Y^{40}) \times \frac{u_0^2}{g} 10^{-4} = 2252 \times \frac{u_0^2}{g} 10^{-4} = 5600 \text{ feet.}$$

In order to find $\log \tau$, we have

$$4680 + 16558 - 1500 - \tfrac{1}{2}5600 = 16938,$$

which gives $\log \tau = 9{\cdot}8087$.

$$\left(\frac{1000}{u_0}\right)^2 = \left(\frac{1000}{u'_{20}}\right)^2 - \frac{K}{g}\frac{d^2}{w}\tau P_{20} = 1{\cdot}72165 - 0{\cdot}36971 = 1{\cdot}35194;$$

$$\therefore\ u_0 = 904{\cdot}4 \text{ f.s. and } \gamma = 0{\cdot}2399.$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| $-40°$ | 0·2399 | 7020 | −2767 | 7663 | 1086 |
| $-20°$ | „ | 3357 | − 594·8 | 3494 | |
| | | ${}_{20}x_{40} = 9307 \text{ ft.}$ | ${}_{20}y_{40} = -5519{\cdot}1 \text{ ft.}$ | ${}_{20}t_{40} = 11''{\cdot}712$ | $v'_{40} = 982{\cdot}1 \text{ f.s.}$ |

and $\left(\frac{1000}{u'_{40}}\right)^2 = \left(\frac{1000}{u_0}\right)^2 + \frac{K}{g}\frac{d^2}{w}\tau P_{40} = 1{\cdot}35194 + 1{\cdot}00789 = 2{\cdot}35983;$

$$\therefore\ u'_{40} = 751{\cdot}12 \text{ f.s.}$$

The shot is now $+16558{\cdot}0 - 1500{\cdot}3 - 5519{\cdot}1 = 9538{\cdot}6$ feet above the level of the muzzle, and therefore the mean height above muzzle will be 4769 feet which must be diminished by 13 feet, because the arc we intend to calculate extends to 27 feet below the level of the muzzle. Therefore

$$4769 - 13 + 4680 = 9436 \text{ feet},$$

which gives $\log \tau = 9{\cdot}9257$.

$$\left(\frac{1000}{u_0}\right)^3 = \left(\frac{1000}{u'_{40}}\right)^3 - \frac{K}{g}\frac{d^2}{w}\tau P_{40} = 2{\cdot}3598 - 1{\cdot}3195 = 1{\cdot}0403;$$

$$\therefore\ u_0 = 986{\cdot}9 \text{ f. s. and } \gamma = 0{\cdot}4081.$$

| $\phi$ | $\gamma$ | (X) | (Y) | (T) |
|---|---|---|---|---|
| $-40°$ | 0·4081 | 6391 | $-2442$ | 7300 |

The shot has to fall vertically $9538{\cdot}6 + 27 = 9565{\cdot}6$ feet. And

$$9565{\cdot}6 \times 10^4 \div \frac{u_0^2}{g} = 3161,$$

which being added to 2442 the value of $({}^0Y^{40})$ gives $({}^0Y^{\phi}) = 5603$, and referring to the Table it will be found that $\phi$ falls between $-54°$ and $-55°$.

| $\phi$ | $\gamma$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|---|
| $-54°$ | 0·4081 | 9039 | $-5337$ | 11069 | 1096 |
| $-55°$ | „ | 9251 | $-5634$ | 11399 | 1105 |

which gives

| | | | | | |
|---|---|---|---|---|---|
| $-54°{\cdot}9$ | „ | 9230 | $-5603$ | 11366 | 1106 |
| But $-40°{\cdot}0$ | „ | 6391 | $-2442$ | 7300 | —— |

$${}_{40}x_{549} = 8587 \text{ ft.};\ {}_{40}y_{549} = -9565{\cdot}6 \text{ ft.};\ {}_{40}t_{549} = 12''{\cdot}463;\ v'_{549} = 1091 \text{ f.s.}$$

| | | | | | |
|---|---|---|---|---|---|
| But ${}_{20}x_{40}$ | = 9307 „ | ${}_{20}y_{40}$ | $= -5519{\cdot}1$ „ | ${}_{20}t_{40}$ | = 11 ·713 |
| ${}_0x_{20}$ | = 8438 „ | ${}_0y_{20}$ | $= -1500{\cdot}3$ „ | ${}_0t_{20}$ | = 9 ·767 |
| ${}_0x_{549}$ | = 26332 ft. | ${}_{40}y_{549}$ | = −16585·0 ft.; | ${}_{40}t_{549}$ | = 33 ·943 |
| And ${}_{40}x_0$ | = 32520 „ | ${}_{40}y_0$ | = +16558·0 „ | ${}_{40}t_0$ | = 28 ·548 |
| ${}_{40}X_{549}$ | = 19617 yds. | ${}_{40}Y_{549}$ | = −27·0 ft. | ${}_{40}T_{549}$ | = 62 ·491 |

## CHAPTER VI.

### ON THE MOVEMENT OF ELONGATED PROJECTILES.

"La détermination du mouvement des projectiles oblongs, "lancés par les armes à feu rayées, est un problème tres-complexe "qui pris dans toute sa généralité, présente de grandes difficultés."
St-Robert.

136. In the preceding calculations it has been supposed that the projectile moved in the vertical plane of projection. This would be the case very nearly, if the projectile was spherical and had its centre of gravity coincident with the centre of its figure, the air being at rest. But when an elongated projectile is fired from a rifled gun, the combined action of gravity and of the resistance of the air acting upon it, causes what is called a lateral "drift." The original explanation of this drift was made to depend upon a supposed greater pressure of the air upon the elongated projectile from below than from above, so that the greater friction of the air on the underside of the rotating projectile caused it to deviate to the right or left, according to the direction of its rotation. This difference of friction above and under the projectile may have some slight effect, but it would not be sufficient to produce the amount of lateral "drift" commonly observed. Even if we adopted this explanation we should have a *vertical* drift also caused by the excess of the pressure of the air upwards on the projectile.

137. Magnus gave the true explanation of all drift in 1852, which he illustrated by experiments with the gyroscope. He says: "From these experiments, we may conclude that the "deviation of elongated projectiles is caused by the resistance of "the air seeking to elevate the apex. The elevation thereby "produced is, however, scarcely perceptible, for during rotation "the forces acting on the mass of the projectile so combine them- "selves, that the apex, instead of being elevated, is *moved side-* "*ways*, and indeed, towards the right when the projectile rotates "to the right. In consequence of this motion to the right, the "resistance of the air presses the projectile's centre of gravity "towards the same side, and thus *produces the deviation*. At "the same time the apex sinks, and thus it appears as if the "pressure of the air against the hinder part of the projectile was "greater than that against the fore part, whereas, in fact, this "pressure is greatest on that part of the axis which is placed "between the centre of gravity and the apex[1]."

138. St-Robert published a mathematical treatise on the motion of elongated projectiles[2], in which he confirmed the explanation of drift given by Magnus. He expressed the result of his investigations in the following words: "Tandis que le "centre de gravité du projectile parcourt la trajectoire, celui-ci "tourne uniformément sur son axe de figure, qui reste immobile "dans son intérieur et qui tourne lentement dans l'espace autour "de la tangente à la trajectoire[3]."

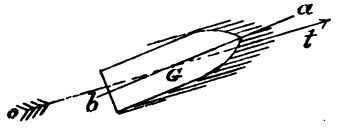
139. Mayevski also published a long paper, *De l'influence du mouvement de rotation sur la trajectoire des projectiles oblongs dans l'air*[4], in which he in a great measure followed St-Robert, and attempted to apply his results to a particular example, where the velocity of projection was low. But he was in error as he explained afterwards[5] when he supposed that the axis of the projectile made several complete revolutions about the tangent. The axis really made oscillations about the tangent whose ampli-

[1] Scientific Memoirs I. 1853, p. 228, and Abweichung der Geschosse, 1860, p. 35.
[2] Journal des Armes spéciales, 1860, and Mémoires Scientifiques, I. pp. 179—312.
[3] Ib. p. 228.
[4] Revue Technologie Militaire, 1866, pp. 1—176.
[5] Traité de Balistique, p. x.

tude did not exceed $\pi$ for the *low* velocity of this projectile. Mayevski has stated the result he arrived at as follows: "Tandis "que le centre de gravité du projectile décrit une certaine trajec- "toire dans l'air, le projectile tourne autour de son axe de figure "avec une vitesse angulaire sensiblement égale à la vitesse an- "gulaire initiale, et l'axe de figure a un mouvement de rotation "autour de la tangente qui s'abaisse pendant toute la durée du "mouvement[1]." He resolves the resistance of the air as follows: "Décomposons la résultante $\rho$ de la résistance en trois autres "résistances: l'une dirigée en sens contraire de la tangente, "l'autre perpendiculaire à la tangente dans le plan horizontal "et la troisième perpendiculaire à la tangente *dans le plan* "*vertical.*" And then Mayevski explains this latter force would *raise* or *depress* the centre of gravity of the projectile according as its apex was above or below the tangent.

140. Suppose that at any instant the plane of the paper passes through the axis of the projectile *ba*, and the tangent to the trajectory *ot* at the point *G*, drawn in the direction of the

Fig. 10.

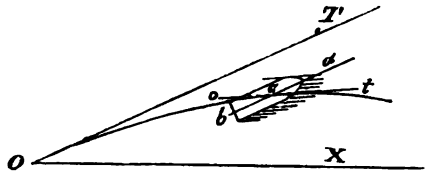



motion of the projectile. Then by what goes before, it appears that the resistance of the air will impart to the centre of gravity *G* of the projectile a motion of *translation* from the tangent *ot* in the plane of the paper, and towards that side, where the apex of the projectile is found. Also the resultant pressure of the air on the projectile will cut the axis between *G* and the apex of the shot. This will tend to increase the angle *tGa*, which however it will not affect sensibly, but will cause the axis *Ga* to *rotate* about the tangent *Gt*, in the same direction as the projectile rotates about its own axis.

[1] Traité de Balistique, p. 236. [2] Ib. p. 239.

141. The attention of Magnus seems to have been confined to the explanation of *lateral* drift of elongated projectiles. But his explanation of that phenomenon requires in addition the consideration of a drift in the *vertical* direction. It also appears to be a common notion that, if an elongated projectile is *perfectly steady* when it leaves a rifled gun, it will continue to move on steadily in the direction of its axis. It is not so, however, for suppose *OT*, Fig. 11, to be the direction of projection, the rapid

Fig. 11.




rotation of the projectile about its axis will tend to keep that axis *ab* parallel to *OT*. But the action of gravity upon the projectile will cause *G*, its centre of gravity, to move in a curve, so that the axis *ba* will become inclined to *Gt* the direction of motion of *G*. The resistance of the air will thus impart a motion of *translation* to the projectile *upwards*, and will also cause *Ga* to begin to describe a conical surface about *Gt*, as already explained. This *vertical* drift is the origin of all drift in a steady projectile.

142. Didion noticed a drift of elongated projectiles in a *vertical* direction, and in a practical case remarked it was equivalent to a reduction in the force of gravity in the ratio of 9·809 to 7·72, and then he adds the remark "Outre cette dérivation "*verticale* il en existe une autre, qui est *horizontale*, et du même "genre, et qu'il importe aussi de connaître, afin de diriger le tir "en conséquence[1]."

143. Various successive positions assumed by an elongated projectile shortly after it leaves the rifled gun are shown by the

[1] Traité de Balistique, 1860, p. 441.

Fig. 12.

diagrams A, B, C, D and E, Fig. 12, when viewed by an eye looking in a direction parallel to the tangent to the trajectory in each case. The curved arrows denote the direction of rotation of the projectile about its own axis, and the straight arrows show the direction in which the resistance of the air acting on the side of the projectile produces a motion of translation of the projectile. When a steady projectile has just left the gun, its base only would be seen, as in diagram A. After a short time the Figure B would represent the appearance of the projectile, where the drift would be entirely in a vertical direction, and *upwards* as denoted by the arrow: and the resistance of the air would cause the point of the projectile to begin to turn to the right. In a short time after, Figure C would represent the state of the case. Here the drift would be in the direction denoted by the arrow. If *ab* be taken to represent the drift in magnitude and direction at this time, then it may be resolved into a horizontal drift *ac* to the right, and a vertical drift *cb* upwards. The axis of the projectile will go on rotating about the tangent to the trajectory till the projectile comes into the position D, where the drift is entirely horizontal and to the right as indicated by the arrow. When the projectile has come to the position D the circumstances of the case will change slowly, for the tangent *Gt* to the trajectory is always dipping downwards, and the action of the resistance of the air in this case will cause the axis of the shot *Ga* also to dip downwards. If the tangent *Gt* dips more rapidly than the axis *Ga*, then the projectile will tend to return to the position shown in Figure C, and the motion will become oscillatory as in the case mentioned by Mayevski (139). This will be likely to happen when the trajectory is much curved, that is, when the velocity of the projectile is low as in the case referred to. But if the axis *Ga* dips faster than the tangent *Gt*, then the projectile will take the position represented by Figure E, where the drift will be in the direction indicated by the arrow. And if *ab* represent the drift in magnitude and direction, it may be resolved into a drift *ac* vertically downwards, and *cb* horizontally to the right. And afterwards the axis *Ga* may go on rotating about the tangent *Gt* and complete one or more revo-

lutions. It should be observed that when the point of the shot is to the right of the vertical plane passing through the tangent, the tangent *Gt* to the trajectory and the axis *Ga* of the projectile are *both dipping downwards*, the rotation of the shot about its own axis being right handed as we have supposed. But when the apex of the projectile is to the left of the vertical plane through the tangent, the tangent *Gt* is *dipping downwards* but the axis *Ga* is *rising upwards*. Hence we may conclude that the drift will be in operation a much longer time to the right than to the left, when the projectile has a right-handed rotation about its own axis.

144. We thus find that the drift *upwards* is the beginning of all drift, and continues in operation from A to B. After passing the position B the drift upwards gradually decreases and vanishes at the position D. But the *horizontal* drift begins to make its appearance as soon as the projectile leaves the position B and gradually increases till it comes to the position D.

145. There can therefore no longer be any doubt that an elongated projectile, although it may leave the gun with perfect steadiness, soon begins to acquire the gyratory motion described by Magnus, St-Robert and Mayevski. At any instant the resistance of the air endeavours to push the projectile bodily from the tangent to its trajectory towards that side on which the apex of the projectile is situated (140). If the axis of the projectile makes one or more complete revolutions about the tangent to the trajectory then there will be a drift in every direction as seen from the gun. But we have no reason to assume that the sum of the *vertical* drift will vanish, so that the resultant drift will be entirely horizontal. With a right-hand rotation of the projectile, although there may be at times a drift to the left, that is very much exceeded by the drift to the right. So also there may be a drift downwards as well as upwards, but it seems to me that the total drift both in a *vertical* and *horizontal* direction will be in a great measure determined by what takes place near the gun, or while the projectile passes at a high velocity from position A to D, Fig. 12, and consequently that the projectile will be lifted up and made to move as if it had been fired at a somewhat higher elevation.

146. From what has been said, it appears to be necessary in calculating trajectories to allow an increase of elevation on account of the *vertical* drift, just in the same manner as the "jump" of the gun is allowed for. But this correction will not be quite so satisfactory, because the *vertical* drift does not act instantaneously at the muzzle, but goes on accumulating gradually while the projectile is moving in its trajectory, as already explained (143).

147. As the diagrams A, B, C, D and E, Fig. 12, represent the cross sections of the path swept out by the elongated projectile in its passage through the air, it is evident that, strictly speaking, the sectional area of the projectile at A will afterwards require to be increased, or that the coefficients of resistance must be *increased*, and not diminished according to Krupp's doctrine. It may also be remarked that as the projectile rises, the density of the air and therefore its resistance will diminish, and Tables XX. and XXI. have been prepared to assist in introducing the necessary corrections. But when the projectile rises only to a moderate height, the reduced resistance on this account may be supposed to balance the increased resistance arising from the inclination of the axis of the projectile to the direction of its motion. In such a case, however, a small reduction in the coefficients of resistance will be proper, if the head of the projectile be more pointed than an ogival struck with a radius of one diameter and a half.

148. I have calculated the following ranges for comparison with the Range Tables of the 4-inch B.L. gun, making $d = 4$ in.; $w = 25$ lbs.; muzzle velocity $= 1900$ f.s.; jump 6 minutes. In the first Table I have arranged the results so as to show the comparative ranges and times of flight, given by calculation and experiment for elevations of 1° to 15°. In these calculations the coefficients of Table IV. were used, which were obtained from experiments with ogival-headed shot struck with a radius of one diameter and a half, and no allowance was made for the decreasing density of the air, or for a more acutely pointed shot.

| Elevation | Range | | | Time of Flight | | |
|---|---|---|---|---|---|---|
| | By R. Table | By Calculation | Difference | By R. Table | By Calculation | Difference |
| | yards | yards | yards | | | |
| 1° | 1083 | 1049 | −34 | 1″·97 | 1″·93 | −0″·04 |
| 2 | 1811 | 1817 | +6 | 3″·72 | 3″·71 | −0″·01 |
| 3 | 2400 | 2406 | +6 | 5″·34 | 5″·34 | 0″·00 |
| 4 | 2917 | 2901 | −16 | 6″·93 | 6″·84 | −0″·09 |
| 5 | 3392 | 3338 | −54 | 8″·44 | 8″·24 | −0″·20 |
| 6 | 3820 | 3738 | −82 | 9″·85 | 9″·58 | −0″·27 |
| 7 | 4213 | 4074 | −139 | 11″·28 | 10″·90 | −0″·38 |
| 8 | 4576 | 4432 | −144 | 12″·65 | 12″·14 | −0″·51 |
| 9 | 4905 | 4741 | −164 | 13″·93 | 13″·36 | −0″·57 |
| 10 | 5215 | 5027 | −188 | 15″·16 | 14″·55 | −0″·61 |
| 11 | 5514 | 5307 | −207 | 16″·39 | 15″·73 | −0″·66 |
| 12 | 5800 | 5562 | −238 | 17″·50 | 16″·86 | −0″·64 |
| 13 | 6086 | 5804 | −282 | 18″·84 | 17″·99 | −0″·85 |
| 14 | ..... | ..... | ..... | ..... | ..... | ..... |
| 15 | 6608 | 6249 | −359 | 21″·34 | 20″·22 | −1″·12 |

149. I have taken from the Range Table the elevations and times of flight corresponding to the above ranges obtained by calculation. I have also used the horizontal muzzle velocities in calculating by the General Tables the times over the same ranges, and the remaining velocities. The results are stated in the following Table:

| Range | Elevation | | | Time of Flight | | | Calc. Horizontal Striking Velocity | General Tables | |
|---|---|---|---|---|---|---|---|---|---|
| | By R. Table | By Calculation | Difference | By R. Table | By Calculation | Difference | | Time | Horizontal Velocity |
| yards | | | | | | | y. s. | | y. s. |
| 1049 | 0° 58′ | 1° | +0° 2′ | 1″·90 | 1″·93 | +0″·03 | 476 | 1″·92 | 474 |
| 1817 | 2° 1′ | 2° | −0° 1′ | 3″·73 | 3″·71 | −0″·02 | 386 | 3″·72 | 386 |
| 2406 | 3° 1′ | 3° | −0° 1′ | 5″·36 | 5″·34 | −0″·02 | 340 | 5″·35 | 342 |
| 2901 | 3° 58′ | 4° | +0° 2′ | 6″·86 | 6″·84 | −0″·02 | 319 | 6″·85 | 319 |
| 3338 | 4° 53′ | 5° | +0° 7′ | 8″·26 | 8″·24 | −0″·02 | 302 | 8″·28 | 301 |
| 3738 | 5° 48′ | 6° | +0° 12′ | 9″·57 | 9″·58 | +0″·01 | 289 | 9″·65 | 286 |
| 4074 | 6° 38′ | 7° | +0° 22′ | 10″·76 | 10″·90 | +0″·14 | 274 | 10″·86 | 275 |
| 4432 | 7° 35′ | 8° | +0° 25′ | 12″·10 | 12″·14 | +0″·04 | 265 | 12″·22 | 263 |
| 4741 | 8° 29′ | 9° | +0° 31′ | 13″·29 | 13″·36 | +0″·07 | 255 | 13″·44 | 254 |
| 5027 | 9° 23′ | 10° | +0° 37′ | 14″·41 | 14″·55 | +0″·14 | 246 | 14″·61 | 246 |
| 5307 | 10° 18′ | 11° | +0° 42′ | 15″·53 | 15″·73 | +0″·20 | 238 | 15″·80 | 237 |
| 5562 | 11° 10′ | 12° | +0° 50′ | 16″·67 | 16″·86 | +0″·19 | 231 | 16″·94 | 230 |
| 5804 | 12° 1′ | 13° | +0° 59′ | 17″·52 | 17″·99 | +0″·47 | 225 | 18″·04 | 223 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 6249 | 13° 36′ | 15° | +1° 24′ | 19″·55 | 20″·22 | +0″·67 | 208 | 20″·19 | 211 |

Here the difference of elevations in each case seems to be

the correction required for vertical drift, inasmuch as that correction gives both ranges and times of flight satisfactorily.

150. It must be borne in mind that my coefficients of resistance were mostly derived from the motion of ogival-headed projectiles fired through ten screens placed 50 yards apart, at elevations calculated to give ranges of 600 or 700 yards. Those projectiles, which passed through all the ten screens, must in general have been steady in their flight. The 5-inch gun was a remarkably good one, which by its accurate shooting gave many records, and consequently many values of the coefficient $K$ for velocities between 1000 and 1650 f.s. But those projectiles, which were unsteady, passed through only a few screens giving very few records, and therefore they could have only a very limited effect on the final results. The coefficients of resistance for velocities 1000 to 1650 f.s. were derived from experiments made with ogival-headed projectiles in 1867, 8 by the use of 3, 5, 7 and 9-inch M.L. guns. This variation in the calibres of the guns was adopted because it was necessary to ascertain in the first place, whether the resistance of the air did really vary as the square of the diameter of the projectile. That law having been found satisfactory, the coefficients of resistance for velocities 1650 to 2250 f.s. were obtained by experiments in 1878, 9 with a new 6-inch B.L. Armstrong gun, and in 1880 these coefficients were extended to velocity 2780 f.s. by experiments made with a new 8-inch B.L. Armstrong gun. The results given by these two guns proved perfectly consistent, as will be found by comparing the Report of Experiments printed in 1879 with the Final Report of 1880. I have the best authority for stating that no English guns constructed since 1880 have hitherto given evidence of any marked improvement in the centering of their projectiles. Numerous examples have been worked out to explain the use of the Tables, and to show how well the calculated agree with the experimental results of recent guns, so long as the elevation of the gun is low, for in that case the projectiles move nearly in the direction of their axes, and *much as they did when my experiments were made.* These comparisons of calculated and experimental results have been found perfectly satisfactory for velocities 1900 to 960 f.s. and for ranges up to 3000 yards. That is full and complete evidence of the accuracy of my coefficients of resistance.

151. As the elevation of the 4-inch gun goes on increasing above 4°, the calculated ranges and times of flight gradually fall short more and more of these values given in the Range Table for the specified elevation (148), but they are consistent with those given for a somewhat lower elevation (149). There is no reason for supposing that the resistance of the air to an elongated projectile fired at an elevation greater than 4° is less than that to the same projectile fired at a lower elevation, excepting for the decreasing density of the air for which special provision has to be made (92). Certainly this discrepancy cannot be corrected by simply reducing the coefficients of resistance as Captain May, R.N., has discovered. For he has observed that "...when the "coefficients used in calculating the time of flight *are the same* "as those which were found to give results agreeing with practice "when used for the calculation of the range, it has *often* been "found that the *calculated time* falls short of the *observed time;* "this would seem to point to the range being prolonged by a "kite-like action of the shell, and if this is so, it may be that "the coefficients which give bad results when applied to the cal- "culation of the range *may not be so erroneous as they appear*[1]."

If the experiments here referred to were good, and if my coefficients had been reduced 5, 10 or 15 per cent.[2] to make the calculated agree with the observed range, it might naturally be expected that the calculated time of flight would fall short of the observed time of flight—because the resistance of the air to the projectile had been unduly reduced. But if my coefficients of resistance had been *properly used,* I feel satisfied that, if not for the given elevation, then for some slightly reduced elevation the calculated range and time of flight would have been found consistent with experiment as in (149). And the proper way to bring calculation into agreement with experiment will be, to make the necessary addition to the elevation, which is accounted for by the *vertical* drift or "the kite-like action" of the shell (143).

152. From the note Captain May appends, I fear he has also made use of some faulty methods of calculation, for he remarks:—"Curiously enough it is usually at comparatively short "ranges, where the trajectory is but little curved that the ob-

[1] Proceedings of the R. A. Inst. XIV. p. 369. [2] Ib. p. 364.

"served time of flight has been found to differ most from the "calculated time. At longer ranges with the same gun they "often agree well[1]." Now I have calculated ranges and times of flight for Captain May's own model Range Table[2] for elevations of 1°, 2°, 3° and 4° the full extent of his Table, and found throughout a most precise agreement between calculation and experiment up to a range of 4000 yards (123). This being the case for low elevations, confirmed by the General Tables (124), I cannot suppose that projectiles fired at higher elevations would require any reduction in the coefficients of resistance, except as above observed so far as the density of the air becomes reduced, and for that I have prepared special corrections.

153. Special experiments were made with the 4-inch B.L. gun in 1887 to test my coefficients of resistance on a long range. I have no confidence in velocities measured by *galvanic* chronographs at considerable distances from the gun. Therefore the initial velocity of each round and the time of flight over a range of 2000 to 3000 yards were measured by the same chronograph, and afterwards the mean experimental and mean calculated times of flight were compared. The results showed that the coefficients were quite satisfactory, as we have found them to be by the use of the Range Table of the same gun for even longer Ranges (125) and (126).

[1] Proceedings of the R. A. Inst. XIV. p. 369. [2] Ib. p. 356.

## CHAPTER VII.

### PROPOSED LAWS OF THE RESISTANCE OF THE AIR TO ELONGATED PROJECTILES.

154. My method of experimenting gave the coefficients of resistance in a form directly applicable to the calculation of General Tables and trajectories. The expression of the law of resistance of the air in terms of the velocity of the projectile was not therefore required for my own purposes. But as such laws seemed to be desired, I endeavoured to give them from time to time for ogival-headed projectiles. The average of the times at which the equidistant screens were passed in the trial of the instrument in 1865 gave a value of $\Delta^2 t$ nearly constant, and thence it was inferred that the resistance varied approximately as the cube of the velocity (38)[1].

155. As there have been many laws of resistance published for ogival-headed projectiles since the commencement of my ballistic experiments, I now propose to state them in the order in which the principal of them appeared and also to apply them, as far as possible, to calculate a standard example, which has been already used for a similar purpose by Major Mackinlay, R.A.[2]. The problem will be to find in each case, by the General Tables, in what Range a 10-inch, or 25·4 c.m. ogival-headed projectile would have its velocity reduced:

(i) from 1700 to 1300 f.s.; or from 518·15 to 396·23 m.s.,

and

(ii) from 1300 to 1100 f.s.; or from 396·23 to 335·27 m.s.

where $w = 412{\cdot}54$ lbs., or 187·12 kgs. which give

$$d^2 \div w = 0{\cdot}2424.$$

[1] Reports, &c. 1865—1870, p. 8. [2] Proceedings of the R. A. Inst. XIV. p. 18.

The ranges calculated by the English Tables will be reduced to the French standard, where $\omega = 527$ grains.

156. We have seen, (106), that my Tables published in 1868, when applied to the 10-inch ogival-headed shell, gave a reduction

(i) from 1700 to 1300 f.s. in velocity in a range of 2534 yards, when reduced to the French standard. And

(ii) from 1300 to 1100 f.s. in a range of 1781 yards.....(*a*).

In 1871, from the results of my experiments in 1867, 8[1], I stated that for ogival-headed projectiles, the resistance of the air might be taken to vary roughly as follows:

$$\left.\begin{array}{ll} v & > 1350 \text{ f.s.};\ f \propto v^2 \\ v < 1350 > 1100 \text{ f.s.};\ & f \propto v^3 \\ v < 1100 > 900 \text{ f.s.};\ & f \propto v^6 \end{array}\right\} \quad \text{.....(b).}$$

My General Table, 1871, gave ranges

(i) of 2584 yards,

and (ii) of 1789 yards.

157. The formulæ deduced by Mayevski[2] from the so-called "résultats des expériences *russes* et anglaises" 1872 were

$$\left.\begin{array}{l} v < 510 > 360 \text{ m.s.};\ \text{or } < 1673 > 1181 \text{ f.s.};\ f \propto v^2 \\ v < 360 > 280 \text{ m.s.};\ \text{or } < 1181 > 919 \text{ f.s.};\ f \propto v^6 \\ v < 280 > 0 \ ;\ \text{or } < 919 > 0 \ ;\ f \propto v^2 \left\{1 + \left(\frac{v}{488}\right)^2\right\} \end{array}\right\} \quad \text{.....(c).}$$

158. My General Tables recalculated in 1873[3] gave ranges

(i) of 2583 yards,

and (ii) of 1790 yards.

The experiments made with my chronograph 1878, 9[4] gave in addition to the laws (*b*),

$$\left.\begin{array}{ll} & v < 1010 > 830 \text{ f.s.};\ f \propto v^3 \\ \text{and} & v < 830 > 430 \text{ f.s.};\ f \propto v^2 \end{array}\right\} \quad \text{.....(d),}$$

[1] Remaining Velocities, 1871, p. 48, and Proceedings of the R. A. Inst. VII. p. 392.
[2] Traité de Balistique, p. 42. [3] Motion of Projectiles.
[4] Report, &c. Part II. 1879.

and the General Table founded on these experiments gave ranges (i) of 2584 yards,

and (ii) of 1785 yards.

159. When Siacci published his Ballistic Tables, (1880), he professed to have founded them upon the so-called "*russe* ed "inglesi" results, but he modified Mayevski's laws[1] (*c*), and brought them more nearly into agreement with my laws (*b*) and (*d*), except for low velocities, as follows:

$$\left.\begin{array}{l} v < 520 > 420 \text{ m.s.}; \text{ or } < 1706 > 1378 \text{ f.s.}; \; f \propto v^2 \\ v < 420 > 343 \text{ m.s.}; \text{ or } < 1378 > 1125 \text{ f.s.}; \; f \propto v^3 \\ v < 343 > 280 \text{ m.s.}; \text{ or } < 1125 > 919 \text{ f.s.}; \; f \propto v^6 \\ v < 280 > 0 \text{ m.s.}; \text{ or } < 919 > 0 \text{ f.s.}; \; f \propto v^2 \left\{1 + \left(\frac{v}{495 \cdot 1}\right)^2\right\} \end{array}\right\} \quad \ldots\ldots\ldots\ldots (e).$$

Siacci's Table $D(v)$, 1880, gives ranges

(i) of 2522 yards,

and (ii) of 1814 yards.

160. Krupp did not attempt to assign any laws of resistance, but they differed little from my own, when my coefficients were reduced 9 or 10 per cent. His Table (1881), gives ranges

(i) of 2847 yards,

and (ii) of 2209 yards.

161. Mayevski (1883), professes to have deduced certain laws from Krupp's Meppen experiments which Ingalls has expressed as follows in English measure[2]:

$$\left.\begin{array}{l} v < 2300 > 1370 \text{ f.s.}; \; f \propto v^2 \\ v < 1370 > 1230 \text{ f.s.}; \; f \propto v^3 \\ v < 1230 > 970 \text{ f.s.}; \; f \propto v^5 \\ v < 970 > 790 \text{ f.s.}; \; f \propto v^3 \\ v < 790 > 0 \text{ f.s.}; \; f \propto v^2 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots (f).$$

The Mayevski-Krupp Table (1873), gives ranges

(i) of 2819 yards,

and (ii) of 2176 yards.

[1] Giornale d' Artiglieria, 1880.

[2] Exterior Ballistics, p. 29.

Here it is manifest that Mayevski completely abandons his original laws (*c*) and approximates to my laws (*b*) and (*d*).

162. Hojel professes to have deduced similar laws from the same experiments, upon which Ingalls remarks[1], that "Hojel has "considered it necessary to employ *fractional exponents*, thereby "sacrificing simplicity without apparently gaining in accuracy." He afterwards compared the results given by the formulæ of Mayevski and Hojel, and by the "Table de Krupp" for velocities 2300 to 400 f.s. and found they agreed[2], so that we may take the law expressed by Mayevski to represent all three.

163. From my Final Report (1880), I deduced the following laws[3]:

$$\begin{aligned}
&v \quad\quad > 1300 \text{ f.s.}; \ f \propto v^2,\\
&v < 1300 > 1100 \text{ f.s.}; \ f \propto v^3,\\
&v < 1100 > 1040 \text{ f.s.}; \ f \propto v^6,\\
&v < 1040 > \ 850 \text{ f.s.}; \ f \propto v^3,\\
&v < \ 850 > \ 100 \text{ f.s.}; \ f \propto v^2.
\end{aligned}$$

164. Ingalls[4] has deduced the following laws from the same Report, 1880:

$$\left.\begin{aligned}
&v \quad\quad > 1330 \text{ f.s.}; \ f \propto v^2\\
&v < 1330 > 1120 \text{ f.s.}; \ f \propto v^3\\
&v < 1120 > \ 990 \text{ f.s.}; \ f \propto v^6\\
&v < \ 990 > \ 790 \text{ f.s.}; \ f \propto v^3\\
&v < \ 790 > \ 100 \text{ f.s.}; \ f \propto v^2
\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (g).$$

Ingalls employed these results when he calculated his Tables, which give ranges

(i) of 2595 yards,

and (ii) of 1775 yards.

My own General Tables, (1889), give ranges

(i) of 2566 yards,

and (ii) of 1781 yards.

[1] Exterior Ballistics, p. 30.
[2] Ib. p. 31.
[3] Nature, xxxiii. p. 605.
[4] Exterior Ballistics, 1886, p. 36.

My Laws of Resistance (1889), finally adopted after the recent revision of all my experiments, will be found in Tables (III) and (IV).

165. The following is a summary of the results above obtained:

| Reduction of velocity | (I) from 1700 f.s. to 1300 f.s. | (II) from 1300 f.s. to 1100 f.s. | or (III) from 1700 f.s. to 1100 f.s. |
|---|---|---|---|
| Bashforth | 1868, 2534 yards, | 1781 yards; | or 4315 yards |
| „ | 1871, 2584 „ , | 1789 „ ; | or 4373 „ |
| „ | 1873, 2583 „ , | 1790 „ ; | or 4373 „ |
| „ | 1879, 2584 „ , | 1785 „ ; | or 4369 „ |
| Siacci | 1880, 2522 „ , | 1814 „ ; | or 4336 „ |
| Krupp | 1881, 2847 „ , | 2209 „ ; | or 5056 „ |
| Mayevski | 1883, 2819 „ , | 2176 „ ; | or 4995 „ |
| Ingalls | 1886, 2595 „ , | 1775 „ ; | or 4370 „ |
| Bashforth | 1889, 2566 „ , | 1781 „ ; | or 4347 „ |

I have now noticed in chronological order the works of those writers on Ballistics mentioned by Ingalls as the authors of Ballistic Tables or of Laws of Resistance of the air to the Motion of Projectiles.

## CHAPTER VIII.

### CONCLUDING REMARKS.

166. As the accuracy of my coefficients of resistance has been questioned, I have gone carefully over all my experimental rounds (53)—(72) and given full particulars of the values of $K$ so obtained (73)—(81). I have also used the means of these coefficients to calculate by Bernoulli's exact method the ranges and times of flight of projectiles fired from the 4-inch B.L. gun (125). The General Tables have also been used to calculate the times of flight of projectiles fired from the same gun (126).

And similar calculations have been made for the 12-inch B.L. gun (123). In every case the agreement between calculation and experiment has been found to be far closer than could reasonably have been expected. The natural conclusion seems to be that my coefficients are well adapted for the calculation of the motion of elongated projectiles fired from *recent* guns for ranges of these guns up to 3000 or 4000 yards, and therefore for all ranges so long as the motion of the projectile in practice corresponds to the motion of the projectiles in my experiments, that is, so long as the projectile moves nearly in the direction of its axis.

167. But as the elevation of the gun increases above 4° or 5° the vertical drift (141) coming into action raises up the elongated projectile so as to give an increased range and time of flight. In such cases my proposal is to *correct the elevation* so that the calculated range and time of flight may agree with those observed quantities. By the careful calculation of good Range Tables it is probable that the law of vertical drift might be

ascertained for elongated projectiles. On the other hand it has been proposed by the Krupp party to *reduce my coefficients* of resistance. But this mode of correcting for range has been found to give too short a time of flight (151), and consequently an erroneous striking velocity. We may now proceed to consider on what authority this proposed reduction of my coefficients depends.

168. Mayevski published the results of some few rounds in 1872, for both spherical and ogival-headed shot[1] accompanied by a statement that these experiments were made in 1868, 9. "Les "expériences de St Pétersbourg sur la résistance de l'air au "mouvement des projectiles *sphériques* et oblongs ont été faites "par nous en 1868 et 1869 et *leurs résultats sont pour la première* "*fois publiés dans notre traité*" (1872). "Afin que les expressions "de la résistance représentent, avec une approximation suffisante, "les résultats de *nos expériences et ceux des expériences anglaises*, "*faites avec des appareils perfectionnés*...pour les *projectiles sphé-* "*riques*...pour les *projectiles* oblongs[2]."

Thus Mayevski both here in his preface and in his work fully acknowledges the use he had made of my published results, for he remarks "Aussi pour compléter les données se rapportant "aux projectiles de forts calibres nous avons profité des tableaux

[1] NOTE. The following is a statement of *all the results* of experiments given by Mayevski for both spherical and oblong projectiles in his Balistique Extérieure, 1872, p. 39.

| $v$ m. s. | $\rho'$ | $v$ m. s. | $\rho'$ | $v$ m. s. | $\rho'$ | $v$ m. s. | $\rho'$ | $v$ m. s. | $\rho'$ |
|---|---|---|---|---|---|---|---|---|---|
| Spherical Projectiles. | | | | | | | | | |
| 227 | 0,0295 | 278 | 0,0424 | 341 | 0,0519 | 384 | 0,0602 | 457 | 0,0598 |
| 234 | 0,0267 | 287 | 0,0411 | 342 | 0,0582 | 408 | 0,0587 | 463 | 0,0611 |
| 262 | 0,0361 | 330 | 0,0491 | 380 | 0,0554 | 415 | 0,0625 | 475 | 0,0625 |
| | | | | | | | | 527 | 0,0619 |
| Oblong Projectiles. | | | | | | | | | |
| 172 | 0,0151 | 247 | 0,0170 | 304 | 0,0221 | 319 | 0,0174 | 337 | 0,0341 |
| 207 | 0,0137 | 266 | 0,0160 | 307 | 0,0158 | 320 | 0,0299 | 360 | 0,0384 |
| 239 | 0,0148 | 282 | 0,0163 | 317 | 0,0259 | 329 | 0,0338 | 401 | 0,0450 |
| | | | | | | | | 409 | 0,0430 |

[2] Traité de Balistique extérieure, 1872, p. vi.

"des vitesses décroissantes[1] déduites par M. Bashforth de ses ex-"périences faites en 1868 au moyen de son chronographe...Nous "avons calculé d'après les résultats insérés dans ces tableaux les "valeurs de la résistance correspondantes à différentes vitesses[2]."

169. Afterwards Mayevski gives in a tabular form some values of Didion's $\rho'$ derived from the published results of my labours, as well as those he had deduced from his own experiments[3], the former being more numerous than the latter. So far everything was as it should be. But unfortunately, immediately afterwards Mayevski spoke of this compound as "les ré-"sultats des expériences *russes* et anglaises." And Siacci in publishing his Ballistic Tables (1880), copied the above-mentioned Table, saying "ecco i resultati dell' esperienze *russe* ed inglesi." And again Siacci in his Balistica (1884), gives a second copy of this precious Table of "esperienze *russe* ed inglesi[4]." Siacci ought to have known that the English experiments were complete in themselves and were published long before Mayevski concocted his Law of Resistance. But to show clearly the value of the Russian element, I have used Siacci's own Table D($v$), said to have been derived from the results "*russe* ed inglesi" to recalculate one of my Tables of decreasing velocities published in 1868, *which Mayevski avowedly made use of* and which has already been reprinted in full (104).

| Distances | Decreasing Velocities | | |
|---|---|---|---|
| Feet | Bashforth's Report, 1868 | Mayevski, 1872, by Siacci's Table | Differences |
| 100 | 1706 *f. s.* | 1706 *f. s.* | 0 *f. s.* |
| 1100 | 1603 | 1605 | +2 |
| 2100 | 1509 | 1509 | 0 |
| 3100 | 1419 | 1420 | +1 |
| 4100 | 1336 | 1336 | 0 |
| 5100 | 1259 | 1261 | +2 |
| 6100 | 1189 | 1194 | +5 |
| 7100 | 1129 | 1134 | +5 |
| 8100 | 1076 | 1082 | +6 |
| 9100 | 1034 | 1040 | +6 |
| 10100 | 1002 | 1005 | +3 |

[1] Proceedings of the R. A. Inst. Notes, 1868.

[2] Mayevski, Traité de Balistique, 1872, p. 38. [3] Ib. p. 41, and Note (168).

[4] Balistica, III. p. 4.

This shows clearly that the effect of the Russian experiments was *nil*, and consequently that Mayevski merely adopted in 1872 my results published in 1868. When experimenters publish the results of their laborious investigations, they know that their results are always open to be tested and examined by any one qualified for such work, but in no case have I met with such a flagrant attempt to appropriate the chief share in the already published work of another.

170. We will now proceed to test Mayevski's experiments with spherical projectiles (1872) in the same manner. In the Report on my experiments with spherical projectiles (1869) a Table of decreasing velocities was given for all the service spherical projectiles (105), just as in the case of the ogival-headed shot above referred to. As Captain Ingalls has used Mayevski's results in preparing Tables for his edition of Siacci's method of calculating trajectories of *spherical* projectiles, I am thus enabled to give a Table of decreasing velocities calculated after Mayevski's results for spherical projectiles (1872) for the 100-Pr. gun at intervals of 1000 feet ($d^2 \div w = 0{\cdot}7766$) for comparison with my own Table published in 1869 as follows:

| Distances | Decreasing Velocities | | |
|---|---|---|---|
| Feet | Bashforth's Report, 1869 | Mayevski, 1872, by Ingall's Table | Differences |
| 400 | 1970 *f. s.* | 1970 *f. s.* | 0 *f. s.* |
| 1400 | 1680 | 1682 | + 2 |
| 2400 | 1437 | 1436 | − 1 |
| 3400 | 1236 | 1226 | − 10 |
| 4400 | 1078 | 1066 | − 12 |
| 5400 | 962 | 950 | − 12 |
| 6000 | 906 | 893 | − 13 |

Here again we have very trifling differences, showing that Mayevski's experiments with spherical shot published in 1872, gave just the same results for all practical purposes as my coefficients gave which were published in 1870.

Hence it appears that the only value of Mayevski's experiments is, so far as they go, to *confirm my previously published coefficients* for both spherical and ogival-headed projectiles.

171. Major Siacci inserted the following note in his Balistica (1884), "La prima tavola balistica fu calcolata sulla base delle "formole (2) della Nota I. dal maggiore Siacci, pubblicando il "*Nuovo Metodo* (*Giornale d' Artiglieria e Genio* P. II. 1880). Un' "altra tavola balistica fondata sulle stesse formole, ma con unità "inglesi, fu calcolata dal tenente Mitcham degli S.U. d' America "(Ordnance Note n. 152). Una terza tavola colle stesse formole "è dovuta al Capitano M. Ingalls degli S.U., il quale ha calco- "lato anche una tavola balistica sui proietti sferici (*Ballistics*, "*Fort Monroe Virginia*, 1883). La casa Krupp ha pubblicato "anche una estesa tavola balistica sulla base delle formole (3) "della Nota I (*Ballistische Formeln von Mayevski, nach Siacci*, "*Essen*, 1883), &c.[1]"

172. Here we find no reference to similar Tables published in England in 1871, 2, 3, 7 &c. for both spherical and ogival-headed projectiles (106)—(110). The simple fact is that Major Siacci uses four Tables in his approximate method of calculating trajectories, three of which had been previously in use in this country, and were well known.

Siacci's Table D $(u)$ 1880 is the same as my Table $\frac{d^2}{w}s$, 1871,

" " T $(u)$ 1880 " " " $\frac{d^2}{w}t$, 1872,

" " J $(u)$ 1880 " " Niven's $D_v \frac{\pi}{180}$, 1877.

My two General Tables were adapted by me for use when the path of the projectile *approximated to a straight line.* And Professor Niven afterwards applied these two tables, with the help of a third table $D_v$ of his own to the calculation of flat trajectories in 1877.[2] These simple matters of fact ought to have been mentioned by Major Siacci, as he pretended to give a history of the tables, for his statement of the case as above quoted is misleading.

173. Captain Ingalls has pointed out certain grave difficulties in the use of Siacci's Equations for Direct Fire, as follows: "As

[1] Balistica, 1884, p. 63.

[2] Proceedings of the Royal Society, 1877.

"already stated, $\alpha$ is some mean value of the secants of the in-"clinations of the extremities of the arc of the trajectory over "which we integrate, and consequently if we take the whole "trajectory lying above the level of the gun, $\alpha$ will be greater "than 1 and less than sec $\omega$. To illustrate, suppose we have for "our data a given projectile fired with a certain known initial "velocity and angle of projection, and we wish to calculate the "angle of fall, terminal velocity, range and time of flight. If "we calculate these elements by means of (75), (72), (76) and "(77) making $\alpha = 1$, they will be too great; while if $\alpha$ is made "equal to sec $\omega$, or even sec $\phi$ they will be too small; and the "correct value of each element would be found by giving to $\alpha$ "*some* value *intermediate to the two.* Moreover, the value of $\alpha$, "which would *give the exact range* would *not give the exact time of* "flight or terminal velocity"[1]! It must be very evident that the approximate calculation of trajectories by Siacci's method as above described, or any similar method involving the use of an arbitrary value of "$\alpha$," cannot be recognised by me as any test whatever of the correctness of my coefficients.

174. It appears[2] that in a recent edition of his Tables, Siacci has given up what he was pleased to name "esperienze *russe* ed "inglesi" and has adopted the laws of resistance which Mayevski professes to have deduced from Krupp's experiments, although he has confessed that "Io non conosco i particolari d' esecuzione "delle sperienze Krupp, nè il metodo con cui furono calcolate le "due tabelle[3]."

175. The late Mr Krupp was famous for his method of employing steel in the construction of big guns, but he appeared in quite a new character as the nominal author of Ballistic Tables in 1881. The second part of the Reports on experiments made by my chronograph, with the help of the first part, 1868, 9, gave coefficients of resistance to ogival-headed projectiles for all velocities between 430 and 2250 f.s., or between 131 and 686 m.s., which were made use of in calculating General Tables 1879. In 1881 Krupp printed in French and German some Ballistic Tables

[1] Exterior Ballistics, p. 115.

[2] Proceedings of the R. A. Inst. XVII. p. 86.

[3] Giornale d' Artiglieria, Pt 2, 1881.

of the same kind as my own which extended from velocity 140 to 700 m.s. But no particulars were given of the experiments, from which he professed to derive materials for his Tables. He merely stated that his Table "a été établi par l'usine Krupp au com-"mencement de l'année 1880," but he did not condescend to particulars, neither did he refer to my results printed two years previously. Having stated that it had been found that no satisfactory general law of resistance of the air as function of the velocity could be found, he then remarked "Cette expérience "devait le faire paraître utile de trouver *une nouvelle* méthode "pour le calcul des vitesses restantes. *Cette méthode a été* "*trouvée de la manière suivante.*" This is quite erroneous as explained (89). For the same method had been previously discovered in a different manner and published, and had been in regular use in England during the preceding ten years 1871—1881. Early copies of these Tables of Krupp were sent over to the United States, America, where they were at once translated, but I was not able to obtain a sight of the precious work till Dec. 1883, and that copy arrived in this country *viâ* America. I then found that Krupp's Tables were based on my Laws of Resistance (Fig. 13), but with the coefficients reduced about 9·3 per cent.[1] Afterwards it appears to have been felt that these Tables lacked support from experiment, for in the following year (1882) an "Annexe", which contained a statement of 37 rounds, apparently selected from old note books 1875 to 1881, was put forward to support the correctness of the so-called "Table de Krupp" (1881). But *in no case was the time of flight given*, and so there was wanting a most important test of accuracy. The chief particulars of the experiments will be found in the accompanying Table (see next page), which also gives the results obtained by Captain Ingalls who recalculated each round of the "Annexe" (1) by Krupp's Table; (2) by his own table based on my results, reduced 9·3 per cent.; and (3) by formulæ of resistance which Mayevski professes to have deduced from Krupp's Meppen experiments.

176. On these results Captain Ingalls has remarked that "The only discrepancies of any account between the calculated "velocities in this column (his own) and the observed velocities

[1] Proceedings of the R. A. Inst. XIII. p. 350.

| No. | Dates | Projectiles | | Poids de l'air en kilogrammes par $m^3$ | Différences entre distances $x_1$ et $x_2$ auxquelles la vitesse fut mesurée en mètres | Vitesses mesurées des Projectiles $v_1$ et $v_2$ en mètres | | Calculated Velocities | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Calibre en mm. | Poids en kilogrammes | | | | | $v$ Computed by Krupp m. s. | $v$ Computed by Table I. m. s. $c=0'907$ | $v$ Computed by Mayevski's Formulas m. s. |
| 1 | 16/11/75 | 240 | 125 | 1·245 | 1450 | 467 | 380 | 379·9 | 380·7 | 380·6 |
| 2 | ,, | ,, | 161 | ,, | ,, | 454·5 | 390 | 388·3 | 387·7 | 387·5 |
| 3 | 18/ 3/76 | 172·6 | 61·5 | 1·226 | 1389 | 477 | 388 | 388·7 | 389·3 | 388·7 |
| 4 | 24/ 3/76 | ,, | ,, | ,, | 1429 | 514·7 | 416·6 | 417·9 | 417·6 | 415·7 |
| 5 | 2/ 3/76 | 149·1 | 39·3 | 1·260 | ,, | 518 | 401·6 | 402·1 | 403·0 | 401·2 |
| 6 | 3/ 3/76 | ,, | 33·5 | 1·240 | ,, | 507·7 | 380 | 380·7 | 379·9 | 379·1 |
| 7 | 30/11/76 | ,, | 31·3 | 1·265 | 924 | 475·8 | 387·8 | 388·2 | 387·7 | 387·3 |
| 8 | 2/ 7/78 | 355 | 525 | 1·200 | 1884 | 495·9 | 432·7 | 433·1 | 433·8 | 432·6 |
| 9 | 11/ 6/79 | ,, | ,, | 1·200 | 2384 | 490 | 415 | 411·8 | 414·4 | 412·3 |
| 10 | 20/ 6/79 | ,, | ,, | 1·200 | 2389 | 488·5 | 409·6 | 410·4 | 412·3 | 410·9 |
| 11 | 17/12/78 | 149·1 | 31·3 | 1·265 | 1950 | 609 | 394 | 393·9 | 395·4 | 392·7 |
| 12 | 7/ 8/79 | ,, | 51 | 1·206 | 1929 | 505·2 | 394·6 | 393·3 | 393·4 | 392·3 |
| 13 | 9/ 8/78 | 152·4 | 51·5 | 1·205 | 1450 | 472·4 | 391·3 | 389·3 | 389·1 | 388·6 |
| 14 | ,, | ,, | 32·5 | ,, | ,, | 577 | 422 | 422·0 | 424·2 | 421·5 |
| 15 | 13/12/78 | 149·1 | 31·3 | 1·230 | ,, | 632·4 | 460·9 | 460·3 | 462·8 | 459·8 |
| 16 | 25/ 6/79 | 240 | 215 | 1·208 | 1904 | 480·4 | 412·8 | 412·0 | 412·4 | 411·1 |
| 17 | 5/ 8/79 | 400 | 777 | 1·180 | 2384 | 499·4 | 433·7 | 432·1 | 433·0 | 431·7 |
| 18 | 6/ 8/79 | ,, | 643 | 1·190 | ,, | 533·4 | 443·8 | 447·0 | 448·2 | 446·6 |
| 19 | ,, | ,, | ,, | 1·190 | ,, | 531·5 | 444·5 | 445·4 | 446·6 | 445·0 |
| 20 | 6/10/76 | 84 | 6·55 | 1·197 | 2447 | 446·9 | 266 | 267·2 | 259·7 | 267·4 |
| 21 | 3/10/76 | 120 | 16·4 | 1·211 | ,, | 463·3 | 284·1 | 289·2 | 281·6 | 289·3 |
| 22 | 12/12/78 | 149·1 | 31·3 | 1·285 | 3448 | 536·6 | 294·8 | 290·6 | 283·7 | 290·5 |
| 23 | 22/ 1/80 | 105 | 16 | 1·300 | 3436 | 481·5 | 282 | 278·4 | 271·2 | 279·6 |
| 24 | 17/ 1/80 | 96 | 12 | 1·340 | 3439 | 425·8 | 256·2 | 250·5 | 244·1 | 254·4 |
| 25 | 26/ 6/80 | 107 | 12·5 | 1·218 | 777·5 | 205·1 | 188·2 | 189·8 | 187·7 | 189·8 |
| 26 | 10/ 7/80 | 152·4 | 31·5 | 1·206 | 966·5 | 203 | 188 | 187·4 | 185·9 | 188·0 |
| 27 | 7/ 7/81 | 105 | 16 | 1·222 | 950 | 514·2 | 426·9 | 421·1 | 422·2 | 420·4 |
| 28 | 11/ 7/81 | 149·1 | 39 | 1·218 | 1429 | 470 | 369·5 | 370·4 | 369·1 | 369·3 |
| 29 | 23/ 6/77 | 283 | 234·7 | 1·206 | 4450 | 464·7 | 321·2 | 318·9 | 311·3 | 317·6 |
| 30 | 25/ 7/81 | ,, | ,, | 1·205 | 1879 | 465·3 | 403·9 | 403·3 | 404·6 | 403·7 |
| 31 | 26/ 7/81 | ,, | ,, | 1·200 | 1919 | 465·9 | 385·4 | 384·7 | 384·0 | 383·8 |
| 32 | ,, | ,, | ,, | ,, | 2425·5 | 466·5 | 370·6 | 368·0 | 366·6 | 367·0 |
| 33 | 27/ 7/81 | ,, | ,, | 1·220 | 2921·5 | 464·8 | 347·8 | 350·9 | 347·7 | 349·7 |
| 34 | 28/ 7/81 | ,, | ,, | 1·227 | 3426·0 | 463·7 | 336·0 | 337·6 | 331·4 | 336·6 |
| 35 | 29/ 7/81 | ,, | ,, | 1·220 | 4446·5 | 460·0 | 316·6 | 316·6 | 308·6 | 315·0 |
| 36 | 1/ 8/81 | ,, | ,, | 1·192 | 5945·0 | 455·8 | 295·0 | 293·9 | 285·6 | 293·0 |
| 37 | 4/ 8/81 | ,, | ,, | 1·206 | ,, | 453·1 | 294·7 | 291·5 | 283·2 | 291 4 |

"occur where the curvature of the trajectory is considerable, as "in the last four rounds, and one or two others. Equation (30) is "based upon the supposition that the *path of the projectile is a* "*horizontal right* line, and of course, gives only *approximate results* "when this path has any appreciable curvature.... In No. 37, "for example, it will be found that to attain a range of 5945 metres "($3\frac{3}{4}$ miles) the angle of projection would have to be 12° 37′, and "the angle of fall would be 17° 40′[1]." Hence it appears that the result of Krupp's labours was a reduction of 9·3 per cent. in my coefficients, and the authority for that reduction depends entirely upon the 37 rounds given in Krupp's "Annexe."

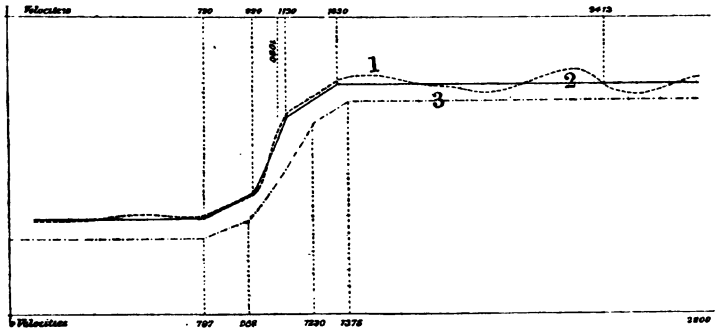
177. When it is desired to find the law of the resistance of the air to the motion of projectiles by the use of chronoscopes of the Navez type, it is necessary to measure the velocities of the projectiles at two points *near together*, and then the resistance required to produce the observed loss of velocity in the *given short range* is usually taken to be the resistance of the air to the projectile when moving with the *mean* of the two measured velocities. But not one of the ranges given in Krupp's Annexe is of moderate length, for they vary from 777 to 5945 metres. Nothing can therefore be known experimentally about the variation of the velocity between the two extremities of each range. Velocities measured at distant stations by chronoscopes have not been found satisfactory. Take the round mentioned in particular by Captain Ingalls (176); the rise in the trajectory near the gun would be 22 in the 100, and the fall at the distant end would be 32 in the 100. Here is a difficult problem to fire a projectile through a pair of screens near the gun and also through another pair 5945 metres off. And if this could be done, the resulting velocities would not be trustworthy under the circumstances above stated.

178. Notwithstanding all these difficulties Mayevski and Hojel have had the courage to attempt to deduce laws of resistance from the Meppen experiments. It appears to me that the only way to proceed in such a case, would be to take some previously determined law and adjust the coefficients so as to obtain the desired results. I have copied the following diagram[2], as it

[1] Proceedings of the R. A. Inst. XIII. p. 62. [2] Ib. XVII. p. 87.

shows clearly the state of the case. The dotted line (1) represents the results given by my experiments (1880); (2) the laws deduced from my experiments by Captain Ingalls[1] (164); and (3) the laws deduced by Mayevski (161), "when the Krupp projectile is "employed[2]". As Ingalls has used both the Krupp Table and

Fig. 13.




Mayevski's laws to calculate the rounds of the Annexe, and found a close agreement between them, (3) may be taken also to represent the laws of resistance on which Krupp's Tables are founded.

179. Immediately after my Report on the experiments of 1878, 9 was printed, it was decided to make experiments with still higher velocities. These experiments, carried out at Shoeburyness, March 8—10, 1880, extended the coefficients of resistance to ogival-headed projectiles to all velocities between 2250 and 2780 f.s., or between 686 and 850 m.s. The Report of these experiments was published 1880[3].

180. The following July experiments were professedly carried on at Meppen: "pour déterminer la résistance de l'air aux grandes "vitesses de projectile" Bulletin XXX. But in the end, all that was attempted was to try "si la résistance de l'air restait pro- "portionelle au carré de vitesse du projectile aussi pour les vi- "tesses de projectile plus grandes que celles expérimentées jus- "qu'ici." Here the details of each round have been given, so that we are able to judge how experiments of this nature were con-

[1] Exterior Ballistics, p. 36. [2] Ib. p. 28.
[3] Final Report.

ducted at Meppen. No less than *six* independent chronographs were used which were arranged so that one pair measured the velocity at station *A*, 30 metres, another pair at *B*, 130 metres, and the remaining pair at *C*, 500 to 1500 metres from the gun. Generally the two measures of the velocity at the *same point* differed considerably and much more than is allowed by the rule laid down by Ingalls, for he says that the difference in the velocities of each shot as determined by two instruments should not exceed one-thousandth of the actual velocity[1].

181. As a curiosity, I copy from Bulletin XXX. the worst group of all, which exceeds belief.

July 5, 1881.

| | Measured velocity at *A* 30 metres from Gun by two Chronoscopes | | | Measured velocity at *B* 130 metres from Gun by two Chronoscopes | | | Measured velocity at *C* 1000 metres from Gun by Chronoscopes | |
|---|---|---|---|---|---|---|---|---|
| Round | No. 301 | No. 302 | Diff. | No. 292 | No. 293 | Diff. | No. 114 | No. 115 |
| 7 | 896·4 | 892·5 | + 3·9 | 855·9 | 850·9 | + 5·0 | nil. | nil. |
| 8 | 903·8 | 894·5 | + 9·3 | 852·7 | 862·7 | − 10·0 | nil. | nil. |
| 9 | 907·4 | 887·2 | +20·2 | 857·6 | 856·7 | + 0·9 | 438·1 | nil. |
| 10 | 907·4 | 911·4 | − 4·0 | 854·1 | 834·7 | +19·4 | nil. | nil. |
| Means | 903·8 | 896·4 | + 7·4 | 855·1 | 851·3 | + 3·8 | 438·1 | nil. |
| Means of means | 900·1 m. s. | | | 853·2 m. s. | | | 438·1 m. s. | |

182. Here the two measured velocities of round 9 at station *A* differ by so much as 20·2 m.s., or 66 f.s.; those of round 10, at station *B* differ 19·4 m.s., or 64 f.s.; and other rounds differ 10·0, 9·3, 5·0 4·0 and 3·9 m.s. But that is not the worst, for there was only one solitary unchecked velocity measured at station *C*, and that was treated as a perfectly satisfactory mean velocity at *C* for all the four rounds. The mean velocities so obtained at *A* and *C*, and at *B* and *C*, were combined to calculate a certain coefficient, which was found respectively to be 3·585 and 3·700, and these differed little from the mean value 3·66 finally adopted. But if Krupp had combined the mean velocities at *A* and *B*, he would have obtained 2·584, something very different from 3·66 the value of the constant adopted.

[1] Ballistic Machines, p. 13.

183. Round 27 of Krupp's "Annexe" formed a part of the above-mentioned experiment. It is in reality the mean of *five* rounds. In this case the velocities measured at each station agreed better together. Combining the mean velocities at stations *A* and *C*, and *B* and *C*, the values of the constant were found to be respectively 3·641 and 3·743. But if those at *A* and *B* had been combined in the same way the result would have been found 2·765! It is manifest that such experiments are quite unworthy of attention.

184. Thus it appears that the Report of some experiments made by my chronograph and General Tables for velocities 131—686 m.s. were published in 1879. Krupp professes to have carried out the experiments in the following year, 1880, which formed the basis of his Tables for velocities 140—700 f.s. printed in 1881. These Tables were similar to my own.

Again the Report on experiments with my chronograph, for velocities higher than 686 m.s., was published in 1880, and in the following summer, 1881, Krupp carried out experiments of the same kind (Bulletin XXX.).

185. I believe I am correct in stating that the United States did not adopt the Krupp system of guns, and they certainly have not adopted his Tables, for Captain Ingalls in his Exterior Ballistics, 1886, intended chiefly as text book for officers in U. S. Artillery School, has stated that his table was based "upon the experiments of Bashforth," p. 129.

186. The correct method of calculating the trajectories of projectiles originally given by Bernoulli is that which I have endeavoured to render practically useful for the purpose for which it was intended. If trajectories are correctly calculated by this method, we are quite certain that any error in the result arrived at is entirely due to the defects of the data made use of, and not at all to any defect in the mode of calculation.

187. In order to test the value of the coefficients of resistance in a satisfactory manner, great care must be exercised in selecting really trustworthy experiments. Random shots are of no value. Good Range Tables, where the muzzle velocity can be relied on, seem to be the best, because the ranges and times of flight for

different elevations must respectively be consistent. But the elevations given are liable to be affected by both the "jump" and the "vertical drift" which probably vary with the elevation. It seems to me also probable that the muzzle velocity may vary slightly with the elevation of the gun. A moderate wind might produce an effect upon the range, and still not affect sensibly the time of flight. In common fairness these causes of error *must* be allowed for.

188. As a test of the accuracy of coefficients of resistance for high velocities, I prefer to apply the General Tables to calculate the times of flight for ranges given by the Range Table for elevations below 4° or 5°, because such tests are not sensibly affected by the "jump" or the "vertical drift". Take the Range Table of the 4-inch B.L. gun. Weight of projectile 25 lbs.; muzzle-velocity 1900 f.s.; jump, 6 minutes.

| Experimental Ranges. | 1000 yards. | 2000 yards. | 3000 yards. |
|---|---|---|---|
| Elevation + 6′ | 0° 55′ | 2° 17′ | 4° 10′ |
| Horizontal m. velocity | 1899·76 f.s. | 1898·49 f.s. | 1894·98 f.s. |
| Calc. horizon. striking velocity | 1443·04 f.s. | 1109·03 f.s. | 944·1 f.s. |
| Exp. time of flight | 1″·80 | 4″·21 | 7″·20 |
| Calc. time of flight | 1″·814 | 4″·205 | 7″·171 |
| Difference in time, or | + 0″·014 | − 0″·005 | − 0″·029 |
| Difference in range | − 7 yds. | + 2 yds. | + 9 yds. |

The negative sign in the time of flight here indicates that the coefficients of resistance are too little. As the errors in time are so very minute, it is plain that my coefficients of resistance give admirable results for velocities from 1900 f.s. to 1443 f.s. to 1109 f.s. to 944 f.s., or, for all velocities between 1900 and 944 f.s. No matter at what elevation the gun be fired, so long as the *density of the air remains unaltered*, the same coefficients of resistance must still hold good for all velocities between 1900 and 944 f.s. For the case where the density of the air decreases with the height, proper corrections must be introduced by Tables XX. and XXI. Although the form of the 4-inch projectile is probably more acutely pointed than those used in my experiments, it appears that, if anything, my coefficients are a trifle *too little*.

Krupp's correction would be utterly wrong in this case. This is the gun chosen by the authorities to be used in testing my coefficients in consequence of the Krupp scare. It is also a modern gun.

189. Referring again to the Notes by Captain H. J. May, R.N., on the Method of compiling a Range Table, 1886[1], there will be found a specimen Range Table, which we have already made use of (124), for ranges up to 4000 yards of the 12-inch B.L. gun; muzzle velocity 1892 f.s.; weight of projectile 714 lbs.; jump 6 minutes. Using the horizontal muzzle velocity in the specified cases, the General Tables have been employed to calculate the time of flight as before.

| Experimental Ranges. | 1000 yards | 2000 yards | 3000 yards | 4000 yards |
|---|---|---|---|---|
| Elevation + 6′ | 0° 50′ | 1° 44′ | 2° 46′ | 3° 56′ |
| Horizontal muzzle velocity | 1891·8 f.s. | 1891·14 f.s. | 1889·79 f.s. | 1887·54 f.s. |
| Calc. hor. striking velocity | 1739·15 f.s. | 1593·44 f.s. | 1457·74 f.s. | 1332·10 f.s. |
| Exp. time of flight | 1″·66 | 3″·47 | 5″·44 | 7″·61 |
| Calc. time of flight | 1″·654 | 3″·457 | 5″·428 | 7″·591 |
| Difference in time, or | − 0″·006 | − 0″·013 | − 0″·012 | − 0″·019 |
| Difference in range | + 4 yds. | + 7 yds. | + 6 yds. | + 8 yds. |

190. Here it is manifest that my coefficients give most admirable results for velocity 1892 f.s. to 1739 f.s. to 1593 f.s. to 1458 f.s. and to 1332 f.s. or for all velocities between 1892 and 1332 f.s. And that will hold true for any elevation whatever, so long as the density of the air remains unaltered. The 12-inch B.L. gun is, I believe, a modern gun. The only way to test my coefficients of resistance for *low* velocities is by calculating trajectories. This has been done with great success for one gun (122). In the above two examples the error in range has been found by calculating how far the shot moving with its corresponding velocity would travel in the error of time.

191. The conclusion I arrive at is, that my coefficients of resistance are perfectly satisfactory, and might be used with great advantage in testing all the new heavy guns. I would measure

[1] Proceedings of the R. A. Inst. xiv. p. 356.

the muzzle velocity and time of flight for say an elevation of about 4° by my chronograph. I would also take two or more measures of the muzzle velocity by the best chronoscopes in the service to secure a reliable muzzle velocity. I would then calculate by the General Tables, as above, the time of flight over the given range. If the time of flight of the experimental projectile was then divided by the calculated time of flight over the same range, the result, as it was $<$ or $>1$, would show whether, and to what extent, the experimental projectile was superior or inferior in steadiness to the theoretical projectile. In this way the General Tables might be used as a standard of reference in the trial of new guns, and in process of time it would be found how far calculation might take the place of experiment. This is a matter of great practical importance, if, as I see it stated, a 110-ton gun can only fire 95 rounds, a 67-ton gun only 127 rounds, and a 45-ton gun only 150 rounds before they become respectively unserviceable.

192. I have given in Tables I.—IV. the coefficients of resistance to both spherical and ogival-headed projectiles finally adopted after a most careful re-examination of 502 rounds. In arriving at my conclusion I have had no theory to support and no interest to promote. I have been simply searching for the truth, and I have not been able to discover any satisfactory reason for changing my coefficients. But if any one should still be desirous of making a reduction of $x$ per cent. in using the General Tables, or in calculating an arc of a trajectory, he has only to substitute $\frac{d^2}{w} \cdot \frac{100-x}{100}$ for $\frac{d^2}{w}$. If $x=100$ he will come to the case of no resistance, and if $x>100$ he will have an accelerating force, and all the tables may still be used as directed.

*Titles in full of some Reports, &c., referred to.*

(1) *Reports on Experiments made with the Bashforth Chronograph, to determine the Resistance of the Air to the Motion of Projectiles,* 1865—1870. 84/B/1941. W. Clowes & Son; Harrison & Sons; &c., &c.

(2) *Tables of Remaining Velocity, Time of Flight and Energy of various Projectiles, calculated from the Results of Experiments made with the Bashforth Chronograph,* 1865—1870. London, 1871.

(3) *A Mathematical Treatise on the Motion of Projectiles, founded chiefly on the Results of Experiments made with the Bashforth Chronograph.* London, 1873.

(4) *Supplement to the above.* London, 1881.

(5) *Report on Experiments made with the Bashforth Chronograph to determine the Resistance of the Air to the Motion of Elongated Projectiles.* (Part II.) 1878—79. 84/B/2853. Printed for Her Majesty's Stationery Office, 1879.

(6) Official Copy. 84/B/2909. *Final Report on Experiments made with the Bashforth Chronograph to determine the Resistance of the Air to the Motion of Elongated Projectiles,* 1878—80. W. Clowes & Son; Harrison & Sons; &c., &c.

## I.

Coefficients for the Newtonian Law of the Resistance of the Air to Spherical Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ |
|---|---|---|---|---|---|---|---|---|
| 840 | 118·3 | 3·675 | 1330 | 194·9 | 6·055 | 1820 | 205·8 | 6·393 |
| 850 | 119·7 | 3·718 | 1340 | 195·6 | 6·076 | 1830 | 205·8 | 6·393 |
| 860 | 121·1 | 3·762 | 1350 | 196·2 | 6·095 | 1840 | 205·9 | 6·396 |
| 870 | 122·5 | 3·805 | 1360 | 196·8 | 6·114 | 1850 | 206·1 | 6·402 |
| 880 | 123·9 | 3·849 | 1370 | 197·4 | 6·132 | 1860 | 206·1 | 6·402 |
| 890 | 125·3 | 3·892 | 1380 | 197·9 | 6·148 | 1870 | 206·2 | 6·406 |
| 900 | 126·7 | 3·936 | 1390 | 198·4 | 6·163 | 1880 | 206·4 | 6·412 |
| 910 | 128·1 | 3·979 | 1400 | 198·9 | 6·179 | 1890 | 206·6 | 6·418 |
| 920 | 129·5 | 4·023 | 1410 | 199·4 | 6·194 | 1900 | 206·9 | 6·427 |
| 930 | 130·9 | 4·066 | 1420 | 199·9 | 6·210 | 1910 | 207·2 | 6·437 |
| 940 | 132·4 | 4·113 | 1430 | 200·4 | 6·225 | 1920 | 207·6 | 6·449 |
| 950 | 133·8 | 4·156 | 1440 | 200·9 | 6·241 | 1930 | 207·9 | 6·458 |
| 960 | 135·2 | 4·200 | 1450 | 201·3 | 6·253 | 1940 | 208·2 | 6·468 |
| 970 | 136·8 | 4·250 | 1460 | 201·6 | 6·263 | 1950 | 208·4 | 6·474 |
| 980 | 138·4 | 4·299 | 1470 | 202·0 | 6·275 | 1960 | 208·7 | 6·483 |
| 990 | 140·1 | 4·352 | 1480 | 202·3 | 6·284 | 1970 | 209·0 | 6·493 |
| 1000 | 142·0 | 4·411 | 1490 | 202·7 | 6·297 | 1980 | 209·3 | 6·502 |
| 1010 | 144·2 | 4·480 | 1500 | 203·0 | 6·306 | 1990 | 209·5 | 6·508 |
| 1020 | 146·9 | 4·563 | 1510 | 203·3 | 6·315 | 2000 | 209·8 | 6·517 |
| 1030 | 150·0 | 4·660 | 1520 | 203·5 | 6·322 | 2010 | 210·0 | 6·524 |
| 1040 | 153·3 | 4·762 | 1530 | 203·8 | 6·331 | 2020 | 210·3 | 6·533 |
| 1050 | 156·5 | 4·862 | 1540 | 204·1 | 6·340 | 2030 | 210·4 | 6·536 |
| 1060 | 159·5 | 4·955 | 1550 | 204·3 | 6·347 | 2040 | 210·5 | 6·539 |
| 1070 | 162·3 | 5·042 | 1560 | 204·5 | 6·353 | 2050 | 210·5 | 6·539 |
| 1080 | 164·9 | 5·123 | 1570 | 204·7 | 6·359 | 2060 | 210·5 | 6·539 |
| 1090 | 167·3 | 5·197 | 1580 | 204·9 | 6·365 | 2070 | 210·4 | 6·536 |
| 1100 | 169·6 | 5·269 | 1590 | 205·1 | 6·371 | 2080 | 210·3 | 6·533 |
| 1110 | 171·7 | 5·334 | 1600 | 205·3 | 6·378 | 2090 | 210·1 | 6·527 |
| 1120 | 173·7 | 5·396 | 1610 | 205·4 | 6·381 | 2100 | 209·8 | 6·517 |
| 1130 | 175·6 | 5·455 | 1620 | 205·6 | 6·387 | 2110 | 209·6 | 5·511 |
| 1140 | 177·5 | 5·514 | 1630 | 205·7 | 6·390 | 2120 | 209·3 | 6·502 |
| 1150 | 179·3 | 5·570 | 1640 | 205·8 | 6·393 | 2130 | 209·1 | 6·496 |
| 1160 | 181·0 | 5·623 | 1650 | 205·9 | 6·396 | 2140 | 208·8 | 6·486 |
| 1170 | 182·6 | 5·672 | 1660 | 206·0 | 6·399 | 2150 | 208·6 | 6·480 |
| 1180 | 184·1 | 5·719 | 1670 | 206·1 | 6·402 | 2160 | 208·4 | 6·474 |
| 1190 | 185·4 | 5·759 | 1680 | 206·1 | 6·402 | 2170 | 208·2 | 6·468 |
| 1200 | 186·6 | 5·797 | 1690 | 206·2 | 6·406 | 2180 | 208·0 | 6·461 |
| 1210 | 187·7 | 5·831 | 1700 | 206·2 | 6·406 | 2190 | 207·9 | 6·458 |
| 1220 | 188·6 | 5·859 | 1710 | 206·2 | 6·406 | 2200 | 207·7 | 6·452 |
| 1230 | 189·4 | 5·884 | 1720 | 206·2 | 6·406 | 2210 | 207·5 | 6·446 |
| 1240 | 190·2 | 5·909 | 1730 | 206·2 | 6·406 | 2220 | 207·3 | 6·440 |
| 1250 | 190·9 | 5·930 | 1740 | 206·2 | 6·406 | 2230 | 207·2 | 6·437 |
| 1260 | 191·5 | 5·949 | 1750 | 206·1 | 6·402 | 2240 | 207·0 | 6·430 |
| 1270 | 192·1 | 5·968 | 1760 | 206·1 | 6·402 | 2250 | 206·8 | 6·424 |
| 1280 | 192·6 | 5·983 | 1770 | 206·0 | 6·399 | 2260 | 206·6 | 6·418 |
| 1290 | 193·0 | 5·996 | 1780 | 205·9 | 6·396 | 2270 | 206·4 | 6·412 |
| 1300 | 193·3 | 6·005 | 1790 | 205·9 | 6·396 | 2280 | 206·1 | 6·402 |
| 1310 | 193·7 | 6·017 | 1800 | 205·9 | 6·396 | | | |
| 1320 | 194·3 | 6·036 | 1810 | 205·9 | 6·396 | | | |

## II.

Approximate Law of the Resistance of the Air to the motion of Spherical Projectiles. ($\omega = 534{\cdot}22$ grains.)

$v$ $> 1300$ *f. s.*, $f \propto v^2$, $k = 205{\cdot}3$, $\frac{k}{g} = 6{\cdot}3776$, $\log \frac{k}{g} = 0{\cdot}80466$,

$v < 1300 > 1100$ *f. s.*, $f \propto v^3$, $K = 153{\cdot}8$, $\frac{K}{g} = 4{\cdot}7778$, $\log \frac{K}{g} = 0{\cdot}67923$,

$v < 1100 > 1000$ *f. s.*, $f \propto v^4$, $h = 141{\cdot}6$, $\frac{h}{g} = 4{\cdot}3988$, $\log \frac{h}{g} = 0{\cdot}64333$,

$v < 1000 > 840$ , $f \propto v^3$, $K = 140{\cdot}7$, $\frac{K}{g} = 4{\cdot}3708$, $\log \frac{K}{g} = 0{\cdot}64056$,

$v < 840$ , $f \propto v^2$, $k = 118{\cdot}3$, $\frac{k}{g} = 3{\cdot}6749$, $\log \frac{k}{g} = 0{\cdot}56525$.

## III.

Coefficients for the Newtonian Law of the Resistance of the Air to Ogival-headed Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ *f. s.* | $k_v$ | $\frac{k_v}{g}$ | $v$ *f. s.* | $k_v$ | $\frac{k_v}{g}$ | $v$ *f. s.* | $k_v$ | $\frac{k_v}{g}$ |
|---|---|---|---|---|---|---|---|---|
| 100 | 60·5 | 1·879 | 1110 | 120·3 | 3·737 | 1430 | 147·9 | 4·594 |
| to | ,, | ,, | 1120 | 122·3 | 3·799 | 1440 | 148·0 | 4·598 |
| 810 | 60·5 | 1·879 | 1130 | 123·9 | 3·849 | 1450 | 148·1 | 4·601 |
| 820 | 60·6 | 1·883 | 1140 | 125·0 | 3·883 | 1460 | 148·0 | 4·598 |
| 830 | 61·1 | 1·898 | 1150 | 126·0 | 3·914 | 1470 | 148·0 | 4·598 |
| 840 | 61·8 | 1·920 | 1160 | 127·1 | 3·948 | 1480 | 148·0 | 4·598 |
| 850 | 62·6 | 1·945 | 1170 | 128·2 | 3·983 | 1490 | 147·8 | 4·591 |
| 860 | 63·3 | 1·966 | 1180 | 129·3 | 4·017 | 1500 | 147·6 | 4·585 |
| 870 | 64·0 | 1·988 | 1190 | 130·4 | 4·051 | 1510 | 147·6 | 4·585 |
| 880 | 64·8 | 2·013 | 1200 | 131·5 | 4·085 | 1520 | 147·3 | 4·576 |
| 890 | 65·5 | 2·035 | 1210 | 132·6 | 4·119 | 1530 | 147·1 | 4·570 |
| 900 | 66·2 | 2·057 | 1220 | 133·7 | 4·153 | 1540 | 146·8 | 4·560 |
| 910 | 67·0 | 2·081 | 1230 | 134·8 | 4·188 | 1550 | 146·5 | 4·551 |
| 920 | 67·7 | 2·103 | 1240 | 135·9 | 4·222 | 1560 | 146·2 | 4·542 |
| 930 | 68·4 | 2·125 | 1250 | 137·0 | 4·256 | 1570 | 145·9 | 4·532 |
| 940 | 69·2 | 2·150 | 1260 | 138·1 | 4·290 | 1580 | 145·6 | 4·523 |
| 950 | 69·9 | 2·171 | 1270 | 139·2 | 4·324 | 1590 | 145·2 | 4·511 |
| 960 | 70·7 | 2·196 | 1280 | 140·3 | 4·358 | 1600 | 144·9 | 4·501 |
| 970 | 71·4 | 2·218 | 1290 | 141·4 | 4·393 | 1610 | 144·6 | 4·492 |
| 980 | 72·1 | 2·240 | 1300 | 142·2 | 4·417 | 1620 | 144·4 | 4·486 |
| 990 | 72·9 | 2·265 | 1310 | 142·9 | 4·439 | 1630 | 144·2 | 4·480 |
| 1000 | 73·6 | 2·286 | 1320 | 143·6 | 4·461 | 1640 | 143·9 | 4·470 |
| 1010 | 74·5 | 2·314 | 1330 | 144·3 | 4·483 | 1650 | 143·6 | 4·461 |
| 1020 | 76·1 | 2·364 | 1340 | 144·9 | 4·501 | 1660 | 143·3 | 4·452 |
| 1030 | 78·9 | 2·451 | 1350 | 145·4 | 4·517 | 1670 | 143·0 | 4·442 |
| 1040 | 84·0 | 2·609 | 1360 | 145·8 | 4·529 | 1680 | 142·6 | 4·430 |
| 1050 | 91·7 | 2·849 | 1370 | 146·3 | 4·545 | 1690 | 142·3 | 4·421 |
| 1060 | 99·6 | 3·094 | 1380 | 146·6 | 4·554 | 1700 | 142·0 | 4·411 |
| 1070 | 105·6 | 3·281 | 1390 | 147·1 | 4·570 | 1710 | 141·6 | 4·399 |
| 1080 | 110·2 | 3·423 | 1400 | 147·3 | 4·576 | 1720 | 141·3 | 4·389 |
| 1090 | 114·3 | 3·551 | 1410 | 147·5 | 4·582 | 1730 | 141·0 | 4·380 |
| 1100 | 117·6 | 3·653 | 1420 | 147·7 | 4·588 | 1740 | 140·7 | 4·371 |

III. (*continued*).

| $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ |
|---|---|---|---|---|---|---|---|---|
| 1750 | 140·5 | 4·365 | 2100 | 140·7 | 4·371 | 2450 | 134·1 | 4·166 |
| 1760 | 140·3 | 4·358 | 2110 | 141·2 | 4·386 | 2460 | 133·6 | 4·150 |
| 1770 | 140·1 | 4·352 | 2120 | 141·6 | 4·399 | 2470 | 133·2 | 4·138 |
| 1780 | 139·9 | 4·346 | 2130 | 142·0 | 4·411 | 2480 | 132·9 | 4·129 |
| 1790 | 139·6 | 4·337 | 2140 | 142·5 | 4·427 | 2490 | 132·5 | 4·116 |
| 1800 | 139·3 | 4·327 | 2150 | 143·0 | 4·442 | 2500 | 132·2 | 4·107 |
| 1810 | 139·0 | 4·318 | 2160 | 143·5 | 4·458 | 2510 | 132·3 | 4·110 |
| 1820 | 138·8 | 4·312 | 2170 | 143·9 | 4·470 | 2520 | 132·5 | 4·116 |
| 1830 | 138·6 | 4·306 | 2180 | 144·2 | 4·480 | 2530 | 132·4 | 4·113 |
| 1840 | 138·4 | 4·299 | 2190 | 144·5 | 4·489 | 2540 | 132·5 | 4·116 |
| 1850 | 138·3 | 4·296 | 2200 | 144·8 | 4·498 | 2550 | 132·6 | 4·119 |
| 1860 | 138·2 | 4·293 | 2210 | 145·0 | 4·504 | 2560 | 132·8 | 4·125 |
| 1870 | 138·0 | 4·287 | 2220 | 145·1 | 4·507 | 2570 | 133·1 | 4·135 |
| 1880 | 137·8 | 4·281 | 2230 | 145·2 | 4·511 | 2580 | 133·4 | 4·144 |
| 1890 | 137·5 | 4·271 | 2240 | 145·3 | 4·514 | 2590 | 133·7 | 4·153 |
| 1900 | 137·2 | 4·262 | 2250 | 145·3 | 4·514 | 2600 | 133·9 | 4·160 |
| 1910 | 136·9 | 4·253 | 2260 | 145·1 | 4·507 | 2610 | 134·2 | 4·169 |
| 1920 | 136·7 | 4·247 | 2270 | 144·6 | 4·492 | 2620 | 134·6 | 4·181 |
| 1930 | 136·6 | 4·243 | 2280 | 144·1 | 4·476 | 2630 | 135·2 | 4·200 |
| 1940 | 136·6 | 4·243 | 2290 | 143·6 | 4·461 | 2640 | 135·7 | 4·215 |
| 1950 | 136·5 | 4·240 | 2300 | 143·1 | 4·445 | 2650 | 136·3 | 4·234 |
| 1960 | 136·4 | 4·237 | 2310 | 142·5 | 4·427 | 2660 | 136·8 | 4·250 |
| 1970 | 136·5 | 4·240 | 2320 | 142·0 | 4·411 | 2670 | 137·3 | 4·265 |
| 1980 | 136·6 | 4·243 | 2330 | 141·4 | 4·393 | 2680 | 137·7 | 4·278 |
| 1990 | 136·8 | 4·250 | 2340 | 140·9 | 4·377 | 2690 | 138·1 | 4·290 |
| 2000 | 137·0 | 4·256 | 2350 | 140·2 | 4·355 | 2700 | 138·5 | 4·302 |
| 2010 | 137·2 | 4·262 | 2360 | 139·5 | 4·334 | 2710 | 139·0 | 4·318 |
| 2020 | 137·5 | 4·271 | 2370 | 138·9 | 4·315 | 2720 | 139·4 | 4·330 |
| 2030 | 137·8 | 4·281 | 2380 | 138·2 | 4·293 | 2730 | 139·8 | 4·343 |
| 2040 | 138·1 | 4·290 | 2390 | 137·5 | 4·271 | 2740 | 140·3 | 4·358 |
| 2050 | 138·4 | 4·299 | 2400 | 136·8 | 4·250 | 2750 | 140·8 | 4·374 |
| 2060 | 138·8 | 4·312 | 2410 | 136·2 | 4·231 | 2760 | 141·4 | 4·393 |
| 2070 | 139·2 | 4·327 | 2420 | 135·6 | 4·212 | 2770 | 141·9 | 4·408 |
| 2080 | 139·6 | 4·337 | 2430 | 135·0 | 4·194 | 2780 | 142·4 | 4·424 |
| 2090 | 140·1 | 4·352 | 2440 | 134·5 | 4·178 | | | |

IV.

Approximate Law of the Resistance of the Air to the motion of Ogival-headed Projectiles. ($\omega = 534{\cdot}22$ grains.)

$v > 1300$ f.s., $f \propto v^2$, $k = 141{\cdot}2$, $\frac{k}{g} = 4{\cdot}3864$, $\log \frac{k}{g} = 0{\cdot}64211$,

$v < 1300 > 1100$ f.s., $f \propto v^3$, $K = 109{\cdot}1$, $\frac{K}{g} = 3{\cdot}3891$, $\log \frac{K}{g} = 0{\cdot}53009$,

$v < 1100 > 1000$ f.s., $f \propto v^6$, $L = 77{\cdot}0$, $\frac{L}{g} = 2{\cdot}3920$, $\log \frac{L}{g} = 0{\cdot}37876$,

$v < 1000 > 820$ f.s., $f \propto v^3$, $K = 73{\cdot}6$, $\frac{K}{g} = 2{\cdot}2864$, $\log \frac{K}{g} = 0{\cdot}35915$,

$v < 820$ f.s., $f \propto v^2$, $k = 60{\cdot}5$, $\frac{k}{g} = 1{\cdot}8794$, $\log \frac{k}{g} = 0{\cdot}27402$

## V.

Coefficients for the Newtonian Law of Resistance of the Air to Hemispherical-headed Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $\kappa_1$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $\kappa_1$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $\kappa_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1100 | 146·3 | 4·54 | 1·24 | 1670 | 192·0 | 5·97 | 1·34 | 1780 | 194·0 | 6·03 | 1·39 |
| 1110 | 147·6 | 4·59 | 1·23 | 1680 | 192·7 | 5·99 | 1·35 | 1790 | 193·3 | 6·01 | 1·38 |
| 1120 | 149·0 | 4·63 | 1·22 | 1690 | 193·3 | 6·01 | 1·36 | 1800 | 192·6 | 5·98 | 1·38 |
| 1130 | 150·3 | 4·67 | 1·21 | 1700 | 193·8 | 6·02 | 1·37 | 1810 | 191·9 | 5·96 | 1·38 |
| 1140 | 151·6 | 4·71 | 1·21 | 1710 | 194·3 | 6·03 | 1·37 | 1820 | 190·9 | 5·93 | 1·38 |
| 1150 | 153·0 | 4·75 | 1·21 | 1720 | 194·7 | 6·05 | 1·38 | 1830 | 190·0 | 5·90 | 1·37 |
| 1160 | 154·3 | 4·79 | 1·21 | 1730 | 195·0 | 6·06 | 1·38 | 1840 | 189·0 | 5·87 | 1·37 |
| ..... | ..... | ..... | ..... | 1740 | 195·1 | 6·06 | 1·39 | 1850 | 188·0 | 5·84 | 1·36 |
| 1640 | 189·6 | 5·89 | 1·32 | 1750 | 195·0 | 6·06 | 1·39 | 1860 | 187·1 | 5·81 | 1·35 |
| 1650 | 190·4 | 5·92 | 1·33 | 1760 | 194·8 | 6·05 | 1·39 | 1870 | 186·3 | 5·79 | 1·35 |
| 1660 | 191·2 | 5·94 | 1·33 | 1770 | 194·5 | 6·04 | 1·39 | | | | |

## VI.

Coefficients for the Newtonian Law of Resistance of the Air to Flat-headed Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $\kappa_2$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $\kappa_2$ | $v$ f.s. | $k_v$ | $\frac{k_v}{g}$ | $\kappa_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1530 | 266·7 | 8·28 | 1·81 | 1650 | 286·4 | 8·90 | 2·00 | 1760 | 301·8 | 9·38 | 2·15 |
| 1540 | 268·6 | 8·34 | 1·83 | 1660 | 288·0 | 8·95 | 2·01 | 1770 | 303·0 | 9·41 | 2·16 |
| 1550 | 270·3 | 8·40 | 1·85 | 1670 | 289·4 | 8·99 | 2·02 | 1780 | 304·2 | 9·44 | 2·17 |
| 1560 | 272·2 | 8·46 | 1·86 | 1680 | 291·0 | 9·04 | 2·04 | 1790 | 305·2 | 9·48 | 2·19 |
| 1570 | 274·0 | 8·51 | 1·88 | 1690 | 292·4 | 9·08 | 2·05 | 1800 | 306·0 | 9·51 | 2·20 |
| 1580 | 275·6 | 8·56 | 1·89 | 1700 | 293·9 | 9·13 | 2·07 | 1810 | 306·8 | 9·53 | 2·21 |
| 1590 | 277·1 | 8·61 | 1·91 | 1710 | 295·3 | 9·17 | 2·09 | 1820 | 307·4 | 9·55 | 2·22 |
| 1600 | 278·7 | 8·66 | 1·92 | 1720 | 296·9 | 9·22 | 2·10 | 1830 | 308·0 | 9·57 | 2·22 |
| 1610 | 280·3 | 8·71 | 1·94 | 1730 | 298·3 | 9·27 | 2·12 | 1840 | 308·4 | 9·58 | 2·23 |
| 1620 | 281·9 | 8·76 | 1·95 | 1740 | 299·5 | 9·30 | 2·13 | 1850 | 308·6 | 9·59 | 2·23 |
| 1630 | 283·5 | 8·81 | 1·97 | 1750 | 300·6 | 9·34 | 2·14 | 1860 | 308·6 | 9·59 | 2·23 |
| 1640 | 284·9 | 8·85 | 1·98 | | | | | | | | |

## VII.

$$Q_\phi = \sec\phi \tan\phi + \log_e \tan\left(\frac{\pi}{4} + \frac{\phi}{2}\right).$$

| $\phi$ | ·0 | ·1 | ·2 | ·3 | ·4 | ·5 | ·6 | ·7 | ·8 | ·9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | + |
| 0° | 0·0 0000 | 0349 | 0698 | 1047 | 1396 | 1745 | 2095 | 2444 | 2793 | 3142 | 349 |
| 1 | 0·0 3491 | 3840 | 4190 | 4539 | 4888 | 5238 | 5587 | 5937 | 6286 | 6636 | 350 |
| 2 | 0·0 6986 | 7335 | 7685 | 8035 | 8385 | 8735 | 9085 | 9435 | 9786 | *0136 | 350 |
| 3 | 0·1 0486 | 0837 | 1188 | 1538 | 1889 | 2240 | 2591 | 2942 | 3294 | 3645 | 351 |
| 4 | 0·1 3997 | 4348 | 4700 | 5052 | 5404 | 5757 | 6109 | 6462 | 6814 | 7167 | 352 |
| 5 | 0·1 7520 | 7873 | 8227 | 8580 | 8934 | 9288 | 9642 | 9996 | *0350 | *0705 | 354 |
| 6 | 0·2 1059 | 1414 | 1770 | 2125 | 2481 | 2836 | 3192 | 3549 | 3905 | 4262 | 356 |
| 7 | 0·2 4618 | 4976 | 5332 | 5691 | 6048 | 6406 | 6765 | 7123 | 7482 | 7841 | 358 |
| 8 | 0·2 8200 | 8560 | 8920 | 9280 | 9640 | *0001 | *0362 | *0723 | *1085 | *1447 | 361 |
| 9 | 0·3 1809 | 2171 | 2534 | 2897 | 3260 | 3624 | 3988 | 4352 | 4717 | 5082 | 364 |
| 10 | 0·3 5447 | 5813 | 6179 | 6545 | 6912 | 7279 | 7646 | 8014 | 8382 | 8751 | 367 |
| 11 | 0·3 9120 | 9489 | 9858 | *0228 | *0599 | *0969 | *1341 | *1712 | *2084 | *2457 | 371 |
| 12 | 0·4 2829 | 3202 | 3576 | 3950 | 4325 | 4700 | 5075 | 5451 | 5827 | 6203 | 375 |
| 13 | 0·4 6581 | 6958 | 7336 | 7715 | 8094 | 8473 | 8853 | 9233 | 9614 | 9996 | 379 |
| 14 | 0·5 0378 | 0760 | 1143 | 1526 | 1910 | 2294 | 2679 | 3065 | 3451 | 3837 | 384 |
| 15 | 0·5 4224 | 4612 | 5000 | 5389 | 5778 | 6168 | 6558 | 6949 | 7341 | 7733 | 390 |
| 16 | 0·5 8126 | 8519 | 8913 | 9307 | 9702 | *0098 | *0494 | *0891 | *1289 | *1687 | 396 |
| 17 | 0·6 2086 | 2485 | 2885 | 3286 | 3687 | 4090 | 4492 | 4896 | 5300 | 5704 | 402 |
| 18 | 0·6 6110 | 6516 | 6923 | 7330 | 7739 | 8148 | 8557 | 8968 | 9379 | 9791 | 409 |
| 19 | 0·7 0203 | 0616 | 1030 | 1445 | 1861 | 2277 | 2694 | 3112 | 3531 | 3950 | 416 |
| 20 | 0·7 4371 | 4792 | 5214 | 5636 | 6060 | 6484 | 6909 | 7335 | 7762 | 8190 | 424 |
| 21 | 0·7 8619 | 9048 | 9478 | 9910 | *0342 | *0774 | *1208 | *1643 | *2079 | *2515 | 433 |
| 22 | 0·8 2953 | 3391 | 3830 | 4270 | 4712 | 5154 | 5597 | 6041 | 6486 | 6932 | 442 |
| 23 | 0·8 7380 | 7828 | 8277 | 8727 | 9178 | 9630 | *0083 | *0537 | *0992 | *1449 | 452 |
| 24 | 0·9 1906 | 2364 | 2824 | 3284 | 3746 | 4209 | 4672 | 5137 | 5603 | 6071 | 463 |
| 25 | 0·9 6539 | 7008 | 7479 | 7951 | 8424 | 8898 | 9373 | 9850 | *0327 | *0806 | 474 |
| 26 | 1·0 1286 | 1768 | 2250 | 2734 | 3219 | 3706 | 4193 | 4682 | 5173 | 5664 | 486 |
| 27 | 1·0 6157 | 6651 | 7147 | 7643 | 8141 | 8641 | 9142 | 9644 | *0148 | *0653 | 500 |
| 28 | 1·1 1159 | 1667 | 2176 | 2687 | 3199 | 3712 | 4227 | 4744 | 5262 | 5781 | 514 |
| 29 | 1·1 6302 | 6825 | 7349 | 7874 | 8402 | 8930 | 9460 | 9992 | *0526 | *1061 | 529 |
| 30 | 1·2 1597 | 2136 | 2675 | 3217 | 3760 | 4305 | 4851 | 5400 | 5950 | 6501 | 545 |
| 31 | 1·2 7055 | 7610 | 8167 | 8725 | 9286 | 9848 | *0412 | *0978 | *1546 | *2115 | 562 |
| 32 | 1·3 2687 | 3260 | 3835 | 4412 | 4991 | 5572 | 6155 | 6739 | 7326 | 7915 | 581 |
| 33 | 1·3 8506 | 9098 | 9693 | *0290 | *0889 | *1490 | *2093 | *2698 | *3305 | *3915 | 601 |
| 34 | 1·4 4526 | 5140 | 5756 | 6374 | 6994 | 7617 | 8241 | 8868 | 9498 | *0129 | 623 |
| 35 | 1·5 0763 | 1399 | 2038 | 2679 | 3322 | 3968 | 4616 | 5267 | 5920 | 6575 | 646 |
| 36 | 1·5 7233 | 7894 | 8557 | 9222 | 9890 | *0561 | *1234 | *1910 | *2589 | *3270 | 671 |
| 37 | 1·6 3954 | 4641 | 5330 | 6022 | 6717 | 7414 | 8115 | 8818 | 9524 | *0233 | 698 |
| 38 | 1·7 0945 | 1660 | 2378 | 3099 | 3823 | 4549 | 5279 | 6012 | 6748 | 7487 | 727 |
| 39 | 1·7 8229 | 8974 | 9722 | *0474 | *1229 | *1987 | *2749 | *3513 | *4281 | *5053 | 758 |
| 40 | 1·8 5828 | 6606 | 7388 | 8173 | 8961 | 9753 | *0549 | *1348 | *2151 | *2958 | 792 |
| 41 | 1·9 3768 | 4582 | 5399 | 6221 | 7046 | 7875 | 8708 | 9544 | *0385 | *1229 | 829 |

## VII. $Q_\phi = \sec\phi\tan\phi + \log_e \tan\left(\frac{\pi}{4}+\frac{\phi}{2}\right)$ (*continued*).

| $\phi$ | ·0 | ·1 | ·2 | ·3 | ·4 | ·5 | ·6 | ·7 | ·8 | ·9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | + |
| 42° | 2·0 2078 | 2931 | 3787 | 4648 | 5513 | 6382 | 7255 | 8132 | 9014 | 9899 | 869 |
| 43 | 2·1 0789 | 1684 | 2583 | 3486 | 4394 | 5306 | 6223 | 7145 | 8071 | 9001 | 912 |
| 44 | 2·1 9937 | *0877 | *1822 | *2772 | *3726 | *4686 | *5650 | *6620 | *7594 | *8574 | 960 |
| 45 | 2· 2956 | 3055 | 3154 | 3254 | 3355 | 3456 | 3558 | 3660 | 3763 | 3866 | 101 |
| 46 | 2· 3970 | 4074 | 4179 | 4285 | 4391 | 4498 | 4605 | 4713 | 4821 | 4931 | 107 |
| 47 | 2· 5040 | 5151 | 5262 | 5373 | 5485 | 5598 | 5712 | 5826 | 5941 | 6056 | 113 |
| 48 | 2· 6173 | 6289 | 6407 | 6525 | 6644 | 6764 | 6884 | 7005 | 7127 | 7249 | 120 |
| 49 | 2· 7373 | 7497 | 7621 | 7747 | 7873 | 8000 | 8128 | 8257 | 8386 | 8516 | 127 |
| 50 | 2· 8647 | 8779 | 8912 | 9045 | 9180 | 9315 | 9451 | 9588 | 9726 | 9864 | 135 |
| 51 | 3· 0004 | 0144 | 0286 | 0428 | 0571 | 0716 | 0861 | 1007 | 1154 | 1302 | 144 |
| 52 | 3· 1451 | 1601 | 1753 | 1905 | 2058 | 2212 | 2367 | 2524 | 2681 | 2839 | 154 |
| 53 | 3· 2999 | 3160 | 3322 | 3485 | 3649 | 3814 | 3980 | 4148 | 4317 | 4487 | 165 |
| 54 | 3· 4658 | 4831 | 5004 | 5179 | 5356 | 5533 | 5712 | 5893 | 6074 | 6257 | 178 |
| 55 | 3· 6441 | 6627 | 6814 | 7003 | 7193 | 7384 | 7577 | 7771 | 7967 | 8164 | 192 |
| 56 | 3· 8363 | 8563 | 8765 | 8969 | 9174 | 9381 | 9589 | 9799 | *0011 | *0225 | 207 |
| 57 | 4· 0440 | 0657 | 0876 | 1096 | 1318 | 1542 | 1768 | 1996 | 2226 | 2458 | 224 |
| 58 | 4· 2691 | 2927 | 3164 | 3404 | 3645 | 3889 | 4135 | 4383 | 4633 | 4885 | 244 |
| 59 | 4· 5139 | 5396 | 5655 | 5916 | 6180 | 6445 | 6714 | 6984 | 7257 | 7533 | 266 |
| 60 | 4· 7811 | 8091 | 8374 | 8660 | 8948 | 9239 | 9533 | 9829 | *0129 | *0431 | 291 |
| 61 | 5· 0736 | 1043 | 1354 | 1668 | 1984 | 2304 | 2627 | 2953 | 3282 | 3615 | 320 |
| 62 | 5· 3950 | 4289 | 4632 | 4978 | 5327 | 5680 | 6036 | 6396 | 6760 | 7127 | 353 |
| 63 | 5· 7498 | 7873 | 8252 | 8635 | 9022 | 9412 | 9807 | 0207 | 0610 | 1018 | 391 |
| 64 | 6· 1430 | 1847 | 2268 | 2693 | 3124 | 3559 | 3999 | 4444 | 4893 | 5348 | 435 |
| 65 | 6· 5808 | 6273 | 6743 | 7219 | 7700 | 8187 | 8679 | 9177 | 9681 | 0191 | 487 |
| 66 | 7· 0706 | 1228 | 1756 | 2291 | 2831 | 3379 | 3932 | 4493 | 5061 | 5635 | 548 |
| 67 | 7· 6217 | 6805 | 7402 | 8005 | 8616 | 9235 | 9862 | *0497 | *1140 | *1791 | 620 |
| 68 | 8· 2451 | 3119 | 3796 | 4483 | 5178 | 5882 | 6596 | 7319 | 8052 | 8796 | 705 |
| 69 | 8· 9549 | *0312 | *1087 | *1872 | *2667 | *3475 | *4293 | *5123 | *5965 | *6819 | 808 |
| 70 | 9· 7685 | 8564 | 9455 | *0360 | *1278 | *2210 | *3155 | *4115 | *5088 | *6078 | 933 |
| 71 | 10· 7082 | 8101 | 9136 | *0187 | *1254 | *2338 | *3440 | *4558 | *5695 | *6850 | 1085 |
| 72 | 11· 8023 | 9216 | 0428 | 1660 | 2912 | 4185 | 5480 | 6796 | 8134 | 9496 | 1275 |
| 73 | 13· 0881 | 2290 | 3723 | 5181 | 6665 | 8176 | 9713 | *1278 | *2871 | *4493 | 1512 |
| 74 | 14· 614 | 14·783 | 14·954 | 15·129 | 15·306 | 15·488 | 15·672 | 15·860 | 16·052 | 16·248 | 181 |
| 75 | 16· 447 | 16·650 | 16·858 | 17·069 | 17·285 | 17·505 | 17·730 | 17·959 | 18·193 | 18·432 | 221 |
| 76 | 18· 676 | 18·925 | 19·180 | 19·440 | 19·705 | 19·977 | 20·254 | 20·538 | 20·828 | 21·124 | 272 |
| 77 | 21· 427 | 21·737 | 22·055 | 22·380 | 22·712 | 23·052 | 23·401 | 23·757 | 24·123 | 24·497 | 341 |
| 78 | 24· 881 | 25·274 | 25·677 | 26·091 | 26·514 | 26·949 | 27·396 | 27·854 | 28·324 | 28·806 | 436 |
| 79 | 29· 302 | 29·812 | 30·335 | 30·873 | 31·425 | 31·995 | 32·580 | 33·182 | 33·801 | 34·439 | 571 |

## VIII.

| Log $Q_\phi$ | | | Log $Q_\phi$ | | |
|---|---|---|---|---|---|
| $\phi$ | Log $Q_\phi$ | Log $\Delta Q_\phi$ | $\phi$ | Log $Q_\phi$ | Log $\Delta Q_\phi$ |
| 1° | 8·54297 | 8·54337 | 41° | 0·28728 | 8·91961 |
| 2 | 8·84420 | 8·54417 | 42 | 0·30552 | 8·94009 |
| 3 | 9·02063 | 8·54536 | 43 | 0·32385 | 8·96130 |
| 4 | 9·14603 | 8·54694 | 44 | 0·34230 | 8·98326 |
| 5 | 9·24353 | 8·54894 | 45 | 0·36089 | 9·00600 |
| 6 | 9·32345 | 8·55133 | 46 | 0·37966 | 9·02956 |
| 7 | 9·39126 | 8·55411 | 47 | 0·39864 | 9·05395 |
| 8 | 9·45026 | 8·55732 | 48 | 0·41785 | 9·07921 |
| 9 | 9·50255 | 8·56092 | 49 | 0·43732 | 9·10538 |
| 10 | 9·54958 | 8·56493 | 50 | 0·45708 | 9·13249 |
| 11 | 9·59239 | 8·56935 | 51 | 0·47718 | 9·16058 |
| 12 | 9·63174 | 8·57418 | 52 | 0·49764 | 9·18969 |
| 13 | 9·66821 | 8·57943 | 53 | 0·51850 | 9·21988 |
| 14 | 9·70224 | 8·58511 | 54 | 0·53981 | 9·25119 |
| 15 | 9·73420 | 8·59120 | 55 | 0·56159 | 9·28368 |
| 16 | 9·76437 | 8·59772 | 56 | 0·58391 | 9·31741 |
| 17 | 9·79299 | 8·60467 | 57 | 0·60681 | 9·35244 |
| 18 | 6·82027 | 8·61206 | 58 | 0·63034 | 9·38884 |
| 19 | 9·84636 | 8·61990 | 59 | 0·65456 | 9·42671 |
| 20 | 9·87140 | 8·62816 | 60 | 0·67952 | 9·46611 |
| 21 | 9·89553 | 8·63690 | 61 | 0·70531 | 9·50716 |
| 22 | 9·91883 | 8·64609 | 62 | 0·73199 | 9·54995 |
| 23 | 9·94141 | 8·65574 | 63 | 0·75965 | 9·59461 |
| 24 | 9·96334 | 8·66587 | 64 | 0·78838 | 9·64126 |
| 25 | 9·98470 | 8·67647 | 65 | 0·81828 | 9·69006 |
| 26 | 0·00555 | 8·68757 | 66 | 0·84946 | 9·74117 |
| 27 | 0·02594 | 8·69916 | 67 | 0·88205 | 9·79478 |
| 28 | 0·04595 | 8·71124 | 68 | 0·91620 | 9·85112 |
| 29 | 0·06559 | 8·72386 | 69 | 0·95206 | 9·91042 |
| 30 | 0·08492 | 8·73699 | 70 | 0·98983 | 9·97297 |
| 31 | 0·10399 | 8·75065 | 71 | 1·02971 | 0·03909 |
| 32 | 0·12283 | 8·76487 | 72 | 1·07197 | 0·10917 |
| 33 | 0·14147 | 8·77963 | 73 | 1·11688 | 0·18367 |
| 34 | 0·15995 | 8·79498 | 74 | 1·16478 | 0·26307 |
| 35 | 0·17830 | 8·81090 | 75 | 1·21609 | 0·34811 |
| 36 | 0·19654 | 8·82742 | 76 | 1·27129 | 0·43952 |
| 37 | 0·21472 | 8·84456 | 77 | 1·33097 | 0·53826 |
| 38 | 0·23286 | 8·86233 | 78 | 1·39587 | 0·64556 |
| 39 | 0·25098 | 8·88075 | 79 | 1·46690 | 0·76296 |
| 40 | 0·26911 | 8·89984 | 80 | 1·54526 | |

## IX.

| $\lambda = 0{\cdot}00$ | | | | | $\lambda = 0{\cdot}00$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 27475 | 37743 | 27475 | 2924 | 30° | 5774 | 1667 | 5774 | 1155 |
| 69 | 26051 | 33933 | 26051 | 2790 | 29 | 5543 | 1536 | 5543 | 1143 |
| 68 | 24751 | 30630 | 24751 | 2669 | 28 | 5317 | 1414 | 5317 | 1133 |
| 67 | 23559 | 27750 | 23559 | 2559 | | | | | |
| | | | | | 27 | 5095 | 1298 | 5095 | 1122 |
| 66 | 22460 | 25223 | 22460 | 2459 | 26 | 4877 | 1189 | 4877 | 1113 |
| 65 | 21445 | 22995 | 21445 | 2366 | 25 | 4663 | 1087 | 4663 | 1103 |
| 64 | 20503 | 21019 | 20503 | 2281 | | | | | |
| | | | | | 24 | 4452 | 991·1 | 4452 | 1095 |
| 63 | 19626 | 19259 | 19626 | 2203 | 23 | 4245 | 900·9 | 4245 | 1086 |
| 62 | 18807 | 17686 | 18807 | 2130 | 22 | 4040 | 816·2 | 4040 | 1079 |
| 61 | 18040 | 16273 | 18040 | 2063 | | | | | |
| | | | | | 21 | 3839 | 736·8 | 3839 | 1071 |
| 60 | 17321 | 15000 | 17321 | 2000 | 20 | 3640 | 662·4 | 3640 | 1064 |
| 59 | 16643 | 13849 | 16643 | 1942 | 19 | 3443 | 592·8 | 3443 | 1058 |
| 58 | 16003 | 12805 | 16003 | 1887 | | | | | |
| | | | | | 18 | 3249 | 527·9 | 3249 | 1051 |
| 57 | 15399 | 11856 | 15399 | 1836 | 17 | 3057 | 467·4 | 3057 | 1046 |
| 56 | 14826 | 10990 | 14826 | 1788 | 16 | 2867 | 411·1 | 2867 | 1040 |
| 55 | 14281 | 10198 | 14281 | 1743 | | | | | |
| | | | | | 15 | 2679 | 359·0 | 2679 | 1035 |
| 54 | 13764 | 9472 | 13764 | 1701 | 14 | 2493 | 310·8 | 2493 | 1031 |
| 53 | 13270 | 8805 | 13270 | 1662 | 13 | 2309 | 266·5 | 2309 | 1026 |
| 52 | 12799 | 8191 | 12799 | 1624 | | | | | |
| | | | | | 12 | 2126 | 225·9 | 2126 | 1022 |
| 51 | 12349 | 7625 | 12349 | 1589 | 11 | 1944 | 188·9 | 1944 | 1019 |
| 50 | 11918 | 7101 | 11918 | 1556 | 10 | 1763 | 155·5 | 1763 | 1015 |
| 49 | 11504 | 6617 | 11504 | 1524 | | | | | |
| | | | | | 9 | 1584 | 125·4 | 1584 | 1012 |
| 48 | 11106 | 6167 | 11106 | 1494 | 8 | 1405 | 98·8 | 1405 | 1010 |
| 47 | 10724 | 5750 | 10724 | 1466 | 7 | 1228 | 75·4 | 1228 | 1008 |
| 46 | 10355 | 5362 | 10355 | 1440 | | | | | |
| | | | | | 6 | 1051 | 55·2 | 1051 | 1006 |
| 45 | 10000 | 5000 | 10000 | 1414 | 5 | 875 | 38·3 | 875 | 1004 |
| 44 | 9657 | 4663 | 9657 | 1390 | 4 | 699 | 24·5 | 699 | 1002 |
| 43 | 9325 | 4348 | 9325 | 1367 | | | | | |
| | | | | | 3 | 524 | 13·7 | 524 | 1001 |
| 42 | 9004 | 4054 | 9004 | 1346 | 2 | 349 | 6·1 | 349 | 1001 |
| 41 | 8693 | 3778 | 8693 | 1325 | 1 | 175 | 1·5 | 175 | 1000 |
| 40 | 8391 | 3520 | 8391 | 1305 | 0 | 0 | 0 | 0 | 1000 |
| 39 | 8098 | 3279 | 8098 | 1287 | | | | | |
| 38 | 7813 | 3052 | 7813 | 1269 | | | | | |
| 37 | 7536 | 2839 | 7536 | 1252 | | | | | |
| 36 | 7265 | 2639 | 7265 | 1236 | | | | | |
| 35 | 7002 | 2451 | 7002 | 1221 | | | | | |
| 34 | 6745 | 2275 | 6745 | 1206 | | | | | |
| 33 | 6494 | 2109 | 6494 | 1192 | | | | | |
| 32 | 6249 | 1952 | 6249 | 1179 | | | | | |
| 31 | 6009 | 1805 | 6009 | 1167 | | | | | |

| $\lambda = 0{\cdot}01$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 28628 | 39987 | 28043 | 3078 |
| 69 | 27057 | 35783 | 26547 | 2924 |
| 68 | 25635 | 32170 | 25187 | 2787 |
| 67 | 24340 | 29042 | 23945 | 2663 |

IX. (*continued*).

| $\lambda = 0{\cdot}01$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 66° | 23155 | 26315 | 22804 | 2550 |
| 65 | 22065 | 23922 | 21752 | 2448 |
| 64 | 21059 | 21812 | 20779 | 2355 |
| 63 | 20127 | 19942 | 19874 | 2269 |
| 62 | 19260 | 18275 | 19032 | 2190 |
| 61 | 18450 | 16784 | 18244 | 2117 |
| 60 | 17693 | 15445 | 17506 | 2050 |
| 59 | 16982 | 14238 | 16812 | 1988 |
| 58 | 16314 | 13147 | 16158 | 1929 |
| 57 | 15683 | 12156 | 15540 | 1874 |
| 56 | 15086 | 11255 | 14955 | 1824 |
| 55 | 14521 | 10432 | 14401 | 1776 |
| 54 | 13984 | 9679 | 13874 | 1732 |
| 53 | 13473 | 8989 | 13372 | 1690 |
| 52 | 12987 | 8355 | 12893 | 1650 |
| 51 | 12522 | 7770 | 12436 | 1613 |
| 50 | 12078 | 7231 | 11998 | 1579 |
| 49 | 11652 | 6732 | 11578 | 1546 |
| 48 | 11243 | 6271 | 11175 | 1514 |
| 47 | 10851 | 5842 | 10787 | 1485 |
| 46 | 10473 | 5444 | 10414 | 1457 |
| 45 | 10109 | 5074 | 10055 | 1431 |
| 44 | 9758 | 4729 | 9708 | 1406 |
| 43 | 9419 | 4407 | 9373 | 1382 |
| 42 | 9091 | 4107 | 9048 | 1359 |
| 41 | 8774 | 3826 | 8734 | 1338 |
| 40 | 8466 | 3563 | 8429 | 1318 |

| $\lambda = 0{\cdot}02$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 29943 | 42590 | 28669 | 3260 |
| 69 | 28191 | 37901 | 27089 | 3080 |
| 68 | 26621 | 33913 | 25661 | 2921 |
| 67 | 25204 | 30489 | 24361 | 2780 |
| 66 | 23916 | 27527 | 23172 | 2653 |
| 65 | 22741 | 24946 | 22079 | 2539 |
| 64 | 21661 | 22682 | 21071 | 2436 |

| $\lambda = 0{\cdot}02$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 63° | 20666 | 20685 | 20137 | 2341 |
| 62 | 19744 | 18914 | 19268 | 2255 |
| 61 | 18888 | 17336 | 18458 | 2176 |
| 60 | 18089 | 15924 | 17699 | 2103 |
| 59 | 17342 | 14655 | 16988 | 2036 |
| 58 | 16641 | 13511 | 16318 | 1973 |
| 57 | 15982 | 12476 | 15687 | 1915 |
| 56 | 15360 | 11535 | 15090 | 1861 |
| 55 | 14771 | 10679 | 14524 | 1811 |
| 54 | 14214 | 9898 | 13987 | 1764 |
| 53 | 13685 | 9183 | 13476 | 1719 |
| 52 | 13182 | 8526 | 12989 | 1678 |
| 51 | 12702 | 7923 | 12524 | 1639 |
| 50 | 12243 | 7367 | 12079 | 1602 |
| 49 | 11805 | 6853 | 11653 | 1568 |
| 48 | 11385 | 6379 | 11245 | 1535 |
| 47 | 10982 | 5939 | 10852 | 1505 |
| 46 | 10594 | 5530 | 10474 | 1475 |
| 45 | 10222 | 5151 | 10110 | 1448 |
| 44 | 9862 | 4798 | 9759 | 1422 |
| 43 | 9516 | 4469 | 9420 | 1397 |
| 42 | 9181 | 4162 | 9092 | 1374 |
| 41 | 8857 | 3875 | 8775 | 1352 |
| 40 | 8543 | 3607 | 8467 | 1330 |

| $\lambda = 0{\cdot}03$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 31463 | 45656 | 29366 | 3477 |
| 69 | 29483 | 40356 | 27687 | 3263 |
| 68 | 27731 | 35905 | 26178 | 3077 |
| 67 | 26167 | 32125 | 24812 | 2914 |
| 66 | 24758 | 28884 | 23568 | 2770 |
| 65 | 23481 | 26081 | 22430 | 2641 |
| 64 | 22317 | 23639 | 21382 | 2526 |
| 63 | 21250 | 21498 | 20415 | 2421 |
| 62 | 20267 | 19608 | 19518 | 2327 |
| 61 | 19357 | 17932 | 18682 | 2240 |

IX. (*continued*).

| $\lambda = 0{\cdot}03$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 60° | 18512 | 16438 | 17903 | 2161 |
| 59 | 17725 | 15101 | 17172 | 2088 |
| 58 | 16988 | 13899 | 16486 | 2021 |
| 57 | 16298 | 12814 | 15839 | 1959 |
| 56 | 15648 | 11832 | 15229 | 1901 |
| 55 | 15035 | 10940 | 14652 | 1847 |
| 54 | 14455 | 10128 | 14104 | 1797 |
| 53 | 13906 | 9386 | 13584 | 1751 |
| 52 | 13385 | 8706 | 13088 | 1707 |
| 51 | 12889 | 8082 | 12615 | 1666 |
| 50 | 12416 | 7508 | 12164 | 1627 |
| 49 | 11964 | 6979 | 11731 | 1591 |
| 48 | 11532 | 6490 | 11317 | 1557 |
| 47 | 11117 | 6038 | 10918 | 1525 |
| 46 | 10720 | 5619 | 10536 | 1494 |
| 45 | 10338 | 5230 | 10167 | 1466 |
| 44 | 9970 | 4868 | 9812 | 1438 |
| 43 | 9615 | 4532 | 9469 | 1413 |
| 42 | 9273 | 4218 | 9138 | 1388 |
| 41 | 8942 | 3925 | 8817 | 1365 |
| 40 | 8622 | 3652 | 8506 | 1343 |

| $\lambda = 0{\cdot}04$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 33257 | 49344 | 30152 | 3746 |
| 69 | 30981 | 43250 | 28352 | 3483 |
| 68 | 28999 | 38216 | 26747 | 3261 |
| 67 | 27252 | 33996 | 25304 | 3070 |
| 66 | 25697 | 30418 | 23997 | 2903 |
| 65 | 24300 | 27351 | 22806 | 2757 |
| 64 | 23037 | 24701 | 21715 | 2627 |
| 63 | 21886 | 22392 | 20711 | 2510 |
| 62 | 20833 | 20367 | 19782 | 2405 |
| 61 | 19863 | 18580 | 18920 | 2310 |
| 60 | 18966 | 16995 | 18116 | 2224 |
| 59 | 18134 | 15581 | 17365 | 2145 |
| 58 | 17358 | 14315 | 16661 | 2072 |

| $\lambda = 0{\cdot}04$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 57° | 16633 | 13176 | 15999 | 2005 |
| 56 | 15953 | 12148 | 15374 | 1944 |
| 55 | 15313 | 11217 | 14784 | 1886 |
| 54 | 14709 | 10370 | 14225 | 1833 |
| 53 | 14139 | 9599 | 13695 | 1784 |
| 52 | 13598 | 8894 | 13190 | 1737 |
| 51 | 13084 | 8249 | 12709 | 1694 |
| 50 | 12596 | 7656 | 12250 | 1653 |
| 49 | 12130 | 7110 | 11811 | 1615 |
| 48 | 11684 | 6606 | 11390 | 1579 |
| 47 | 11258 | 6141 | 10986 | 1546 |
| 46 | 10850 | 5711 | 10598 | 1514 |
| 45 | 10458 | 5312 | 10225 | 1484 |
| 44 | 10081 | 4941 | 9865 | 1456 |
| 43 | 9718 | 4597 | 9518 | 1429 |
| 42 | 9368 | 4276 | 9183 | 1404 |
| 41 | 9030 | 3977 | 8859 | 1380 |
| 40 | 8703 | 3698 | 8545 | 1357 |

| $\lambda = 0{\cdot}05$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 35424 | 53902 | 31056 | 4088 |
| 69 | 32747 | 46734 | 29103 | 3755 |
| 68 | 30466 | 40938 | 27381 | 3482 |
| 67 | 28489 | 36164 | 25846 | 3253 |
| 66 | 26754 | 32169 | 24466 | 3058 |
| 65 | 25212 | 28785 | 23215 | 2889 |
| 64 | 23831 | 25887 | 22074 | 2741 |
| 63 | 22583 | 23383 | 21028 | 2609 |
| 62 | 21448 | 21202 | 20064 | 2493 |
| 61 | 20409 | 19288 | 19171 | 2388 |
| 60 | 19454 | 17599 | 18342 | 2293 |
| 59 | 18571 | 16099 | 17569 | 2207 |
| 58 | 17752 | 14762 | 16845 | 2128 |
| 57 | 16988 | 13563 | 16165 | 2056 |
| 56 | 16275 | 12485 | 15526 | 1989 |
| 55 | 15605 | 11511 | 14922 | 1928 |

## IX. (*continued*).

| $\lambda = 0{\cdot}05$ | | | | | $\lambda = 0{\cdot}05$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 54° | 14976 | 10628 | 14351 | 1871 | 15° | 2716 | 365·6 | 2698 | 1050 |
| 53 | 14382 | 9825 | 13810 | 1818 | 14 | 2525 | 316·1 | 2509 | 1044 |
| 52 | 13821 | 9093 | 13296 | 1769 | 13 | 2336 | 270·7 | 2322 | 1038 |
| 51 | 13288 | 8424 | 12806 | 1724 | 12 | 2148 | 229·2 | 2137 | 1033 |
| 50 | 12783 | 7811 | 12339 | 1681 | 11 | 1963 | 191·4 | 1953 | 1029 |
| 49 | 12302 | 7247 | 11893 | 1641 | 10 | 1779 | 157·3 | 1771 | 1025 |
| 48 | 11843 | 6728 | 11466 | 1603 | 9 | 1597 | 126·8 | 1590 | 1021 |
| 47 | 11404 | 6249 | 11056 | 1567 | 8 | 1415 | 99·7 | 1410 | 1017 |
| 46 | 10984 | 5807 | 10663 | 1534 | 7 | 1235 | 76·0 | 1232 | 1014 |
| 45 | 10582 | 5397 | 10285 | 1503 | 6 | 1057 | 55·6 | 1054 | 1011 |
| 44 | 10195 | 5017 | 9921 | 1474 | 5 | 879 | 38·5 | 877 | 1008 |
| 43 | 9823 | 4664 | 9570 | 1446 | 4 | 702 | 24·6 | 700 | 1006 |
| 42 | 9465 | 4336 | 9231 | 1419 | 3 | 526 | 13·8 | 525 | 1004 |
| 41 | 9120 | 4031 | 8903 | 1394 | 2 | 350 | 6·1 | 349 | 1002 |
| 40 | 8786 | 3746 | 8585 | 1370 | +1 | 175 | 1·5 | 175 | 1001 |
| 39 | 8464 | 3480 | 8278 | 1348 | 0 | 0 | 0 | 0 | 1000 |
| 38 | 8152 | 3232 | 7980 | 1327 | −1 | 174 | 1·5 | 175 | 999 |
| 37 | 7849 | 2999 | 7690 | 1307 | 2 | 348 | 6·1 | 349 | 999 |
| | | | | | 3 | 523 | 13·7 | 523 | 999 |
| 36 | 7555 | 2782 | 7408 | 1288 | | | | | |
| 35 | 7270 | 2578 | 7134 | 1270 | 4 | 697 | 24·3 | 698 | 999 |
| 34 | 6993 | 2388 | 6867 | 1252 | 5 | 871 | 38·1 | 873 | 1000 |
| | | | | | 6 | 1045 | 54·9 | 1048 | 1000 |
| 33 | 6722 | 2209 | 6607 | 1236 | | | | | |
| 32 | 6459 | 2041 | 6353 | 1220 | 7 | 1220 | 74·8 | 1224 | 1001 |
| 31 | 6203 | 1884 | 6104 | 1206 | 8 | 1395 | 97·8 | 1400 | 1003 |
| | | | | | 9 | 1571 | 124·1 | 1578 | 1004 |
| 30 | 5952 | 1736 | 5862 | 1192 | | | | | |
| 29 | 5707 | 1597 | 5624 | 1178 | 10 | 1748 | 153·7 | 1755 | 1007 |
| 28 | 5467 | 1467 | 5391 | 1165 | 11 | 1925 | 186·5 | 1934 | 1009 |
| | | | | | 12 | 2103 | 222·7 | 2114 | 1012 |
| 27 | 5233 | 1345 | 5163 | 1152 | | | | | |
| 26 | 5003 | 1231 | 4939 | 1142 | 13 | 2282 | 262·5 | 2295 | 1015 |
| 25 | 4777 | 1123 | 4720 | 1131 | 14 | 2462 | 305·7 | 2478 | 1018 |
| | | | | | 15 | 2644 | 352·6 | 2662 | 1022 |
| 24 | 4556 | 1022 | 4504 | 1121 | | | | | |
| 23 | 4339 | 927·7 | 4291 | 1111 | 16 | 2827 | 403·3 | 2847 | 1026 |
| 22 | 4125 | 839·2 | 4082 | 1102 | 17 | 3011 | 457·9 | 3034 | 1030 |
| | | | | | 18 | 3197 | 516·6 | 3223 | 1035 |
| 21 | 3915 | 756·5 | 3877 | 1093 | | | | | |
| 20 | 3708 | 679·1 | 3674 | 1085 | 19 | 3384 | 579·4 | 3414 | 1040 |
| 19 | 3504 | 606·9 | 3474 | 1077 | 20 | 3574 | 646·5 | 3607 | 1045 |
| | | | | | 21 | 3766 | 718·2 | 3802 | 1051 |
| 18 | 3303 | 539·7 | 3276 | 1069 | | | | | |
| 17 | 3105 | 477·2 | 3081 | 1062 | 22 | 3959 | 794·5 | 4000 | 1057 |
| 16 | 2910 | 419·2 | 2888 | 1056 | 23 | 4156 | 875·8 | 4200 | 1063 |
| | | | | | 24 | 4354 | 962·1 | 4403 | 1070 |

IX. (*continued*).

| $\lambda = 0{\cdot}05$ | | | | | $\lambda = 0{\cdot}05$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 25° | 4555 | 1054 | 4609 | 1078 | 64° | 18244 | 17883 | 19327 | 1995 |
| 26 | 4760 | 1151 | 4818 | 1085 | 65 | 18959 | 19382 | 20147 | 2052 |
| 27 | 4967 | 1255 | 5030 | 1094 | 66 | 19716 | 21043 | 21024 | 2113 |
| 28 | 5177 | 1364 | 5247 | 1102 | 67 | 20519 | 22891 | 21963 | 2178 |
| 29 | 5391 | 1480 | 5466 | 1111 | 68 | 21373 | 24954 | 22972 | 2246 |
| 30 | 5609 | 1603 | 5690 | 1121 | 69 | 22283 | 27263 | 24059 | 2319 |
| 31 | 5830 | 1734 | 5918 | 1131 | 70 | 23253 | 29859 | 25235 | 2397 |
| 32 | 6055 | 1872 | 6151 | 1142 | 71 | 24289 | 32789 | 26509 | 2479 |
| 33 | 6285 | 2018 | 6388 | 1153 | 72 | 25400 | 36109 | 27897 | 2566 |
| 34 | 6520 | 2173 | 6631 | 1165 | 73 | 26591 | 39889 | 29414 | 2659 |
| 35 | 6759 | 2338 | 6879 | 1177 | 74 | 27871 | 44213 | 31079 | 2758 |
| 36 | 7003 | 2512 | 7133 | 1190 | 75 | 29249 | 49185 | 32915 | 2862 |
| 37 | 7253 | 2697 | 7392 | 1204 | 76 | 30734 | 54932 | 34950 | 2973 |
| 38 | 7509 | 2894 | 7659 | 1218 | 77 | 32336 | 61614 | 37217 | 3089 |
| 39 | 7771 | 3102 | 7932 | 1233 | 78 | 34068 | 69431 | 39758 | 3211 |
| 40 | 8040 | 3324 | 8213 | 1249 | 79 | 35939 | 78639 | 42627 | 3338 |
| 41 | 8316 | 3559 | 8501 | 1265 | 80 | 37961 | 89563 | 45890 | 3470 |
| 42 | 8599 | 3810 | 8798 | 1282 | | | | | |
| 43 | 8890 | 4077 | 9104 | 1300 | $\lambda = 0{\cdot}06$ | | | | |
| 44 | 9189 | 4361 | 9419 | 1320 | | | | | |
| 45 | 9498 | 4664 | 9744 | 1340 | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 46 | 9816 | 4988 | 10080 | 1360 | 70° | 38133 | 59745 | 32116 | 4545 |
| 47 | 10144 | 5334 | 10428 | 1382 | 69 | 34883 | 51042 | 29965 | 4102 |
| 48 | 10483 | 5704 | 10788 | 1405 | 68 | 32196 | 44214 | 28096 | 3755 |
| 49 | 10834 | 6100 | 11161 | 1429 | 67 | 29920 | 38715 | 26449 | 3474 |
| 50 | 11197 | 6525 | 11549 | 1455 | 66 | 27956 | 34196 | 24981 | 3240 |
| 51 | 11573 | 6982 | 11952 | 1482 | 65 | 26236 | 30420 | 23659 | 3042 |
| 52 | 11963 | 7473 | 12371 | 1510 | 64 | 24713 | 27223 | 22461 | 2871 |
| 53 | 12369 | 8002 | 12809 | 1540 | 63 | 23349 | 24488 | 21368 | 2722 |
| 54 | 12791 | 8572 | 13265 | 1571 | 62 | 22119 | 22123 | 20364 | 2590 |
| 55 | 13231 | 9188 | 13742 | 1603 | 61 | 21001 | 20064 | 19438 | 2473 |
| 56 | 13689 | 9855 | 14241 | 1638 | 60 | 19979 | 18256 | 18581 | 2368 |
| 57 | 14168 | 10579 | 14765 | 1675 | 59 | 19040 | 16661 | 17783 | 2274 |
| 58 | 14668 | 11365 | 15315 | 1713 | 58 | 18171 | 15243 | 17038 | 2188 |
| 59 | 15193 | 12221 | 15894 | 1754 | 57 | 17366 | 13978 | 16340 | 2110 |
| 60 | 15743 | 13155 | 16505 | 1797 | 56 | 16615 | 12844 | 15684 | 2038 |
| 61 | 16320 | 14176 | 17150 | 1842 | 55 | 15914 | 11823 | 15066 | 1972 |
| 62 | 16928 | 15296 | 17833 | 1891 | | | | | |
| 63 | 17568 | 16526 | 18557 | 1941 | | | | | |

IX. (*continued*).

| $\lambda = 0{\cdot}06$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 54° | 15256 | 10900 | 14482 | 1912 |
| 53 | 14637 | 10064 | 13930 | 1856 |
| 52 | 14053 | 9302 | 13405 | 1803 |
| 51 | 13501 | 8608 | 12906 | 1755 |
| 50 | 12977 | 7973 | 12431 | 1710 |
| 49 | 12480 | 7390 | 11977 | 1667 |
| 48 | 12006 | 6855 | 11543 | 1628 |
| 47 | 11554 | 6362 | 11128 | 1591 |
| 46 | 11122 | 5906 | 10729 | 1556 |
| 45 | 10709 | 5486 | 10346 | 1523 |
| 44 | 10312 | 5096 | 9977 | 1492 |
| 43 | 9931 | 4734 | 9621 | 1463 |
| 42 | 9565 | 4398 | 9278 | 1436 |
| 41 | 9212 | 4086 | 8947 | 1410 |
| 40 | 8871 | 3795 | 8626 | 1385 |

| $\lambda = 0{\cdot}07$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 41699 | 67658 | 33405 | 5200 |
| 69 | 37561 | 56575 | 30979 | 4568 |
| 68 | 34292 | 48267 | 28918 | 4105 |
| 67 | 31609 | 41785 | 27129 | 3747 |
| 66 | 29348 | 36580 | 25554 | 3460 |
| 65 | 27403 | 32310 | 24148 | 3222 |
| 64 | 25705 | 28747 | 22884 | 3022 |
| 63 | 24203 | 25732 | 21736 | 2850 |
| 62 | 22860 | 23152 | 20687 | 2700 |
| 61 | 21650 | 20922 | 19724 | 2569 |
| 60 | 20551 | 18978 | 18834 | 2452 |
| 59 | 19546 | 17272 | 18009 | 2348 |
| 58 | 18623 | 15765 | 17241 | 2254 |
| 57 | 17770 | 14426 | 16523 | 2169 |
| 56 | 16979 | 13230 | 15850 | 2091 |
| 55 | 16242 | 12157 | 15216 | 2021 |
| 54 | 15553 | 11191 | 14619 | 1955 |
| 53 | 14906 | 10317 | 14054 | 1895 |
| 52 | 14298 | 9524 | 13519 | 1839 |

| $\lambda = 0{\cdot}07$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 51° | 13724 | 8803 | 13011 | 1788 |
| 50 | 13181 | 8144 | 12527 | 1740 |
| 49 | 12667 | 7541 | 12065 | 1695 |
| 48 | 12177 | 6988 | 11624 | 1654 |
| 47 | 11711 | 6479 | 11202 | 1615 |
| 46 | 11267 | 6011 | 10797 | 1578 |
| 45 | 10842 | 5578 | 10409 | 1544 |
| 44 | 10434 | 5178 | 10035 | 1511 |
| 43 | 10044 | 4807 | 9675 | 1481 |
| 42 | 9668 | 4463 | 9328 | 1452 |
| 41 | 9307 | 4143 | 8992 | 1425 |
| 40 | 8959 | 3846 | 8668 | 1400 |

| $\lambda = 0{\cdot}08$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 70° | 46794 | 79353 | 35058 | 6255 |
| 69¾ | 45170 | 74922 | 34284 | 5952 |
| 69½ | 43694 | 70947 | 33555 | 5686 |
| 69¼ | 42342 | 67355 | 32866 | 5450 |
| 69 | 41096 | 64087 | 32211 | 5240 |
| 68¾ | 39942 | 61099 | 31589 | 5050 |
| 68½ | 38867 | 58354 | 30995 | 4877 |
| 68¼ | 37863 | 55820 | 30426 | 4720 |
| 68 | 36921 | 53473 | 29882 | 4576 |
| 67¾ | 36034 | 51292 | 29360 | 4442 |
| 67½ | 35197 | 49258 | 28858 | 4319 |
| 67¼ | 34405 | 47358 | 28375 | 4204 |
| 67 | 33653 | 45576 | 27909 | 4097 |
| 66 | 30988 | 39442 | 26198 | 3731 |
| 65 | 28751 | 34528 | 24691 | 3439 |
| 64 | 26832 | 30503 | 23347 | 3199 |
| 63 | 25159 | 27146 | 22136 | 2997 |
| 62 | 23682 | 24306 | 21036 | 2825 |
| 61 | 22362 | 21875 | 20030 | 2676 |
| 60 | 21174 | 19773 | 19105 | 2545 |
| 59 | 20095 | 17941 | 18250 | 2429 |

IX. (*continued*).

$\lambda = 0{\cdot}08$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 58° | 19109 | 16332 | 17456 | 2326 |
| 57 | 18203 | 14909 | 16716 | 2232 |
| 56 | 17366 | 13644 | 16023 | 2148 |
| 55 | 16590 | 12514 | 15373 | 2071 |
| 54 | 15866 | 11500 | 14762 | 2001 |
| 53 | 15190 | 10585 | 14184 | 1937 |
| 52 | 14555 | 9758 | 13637 | 1878 |
| 51 | 13958 | 9007 | 13118 | 1823 |
| 50 | 13394 | 8323 | 12625 | 1772 |
| 49 | 12861 | 7698 | 12155 | 1725 |
| 48 | 12355 | 7126 | 11707 | 1681 |
| 47 | 11874 | 6601 | 11278 | 1640 |
| 46 | 11416 | 6118 | 10867 | 1601 |
| 45 | 10978 | 5673 | 10473 | 1565 |
| 44 | 10560 | 5262 | 10094 | 1531 |
| 43 | 10159 | 4882 | 9730 | 1500 |
| 42 | 9775 | 4529 | 9378 | 1470 |
| 41 | 9405 | 4202 | 9039 | 1441 |
| 40 | 9049 | 3898 | 8711 | 1415 |

$\lambda = 0{\cdot}09$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 70° | 55375 | 99919 | 37405 | 8411 |
| 69¾ | 52545 | 92196 | 36384 | 7718 |
| 69½ | 50134 | 85701 | 35453 | 7167 |
| 69¼ | 48035 | 80124 | 34594 | 6715 |
| 69 | 46180 | 75259 | 33795 | 6334 |
| 68¾ | 44520 | 70962 | 33049 | 6009 |
| 68½ | 43019 | 67127 | 32346 | 5726 |
| 68¼ | 41651 | 63676 | 31684 | 5477 |
| 68 | 40395 | 60547 | 31055 | 5256 |
| 67¾ | 39235 | 57694 | 30458 | 5058 |
| 67½ | 38159 | 55079 | 29889 | 4879 |
| 67¼ | 37155 | 52670 | 29345 | 4716 |
| 67 | 36215 | 50443 | 28824 | 4567 |
| 66¾ | 35333 | 48376 | 28324 | 4430 |
| 66½ | 34501 | 46452 | 27844 | 4304 |

$\lambda = 0{\cdot}09$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 66¼° | 33715 | 44655 | 27382 | 4186 |
| 66 | 32970 | 42972 | 26936 | 4077 |
| 65 | 30336 | 37186 | 25301 | 3706 |
| 64 | 28131 | 32560 | 23860 | 3412 |
| 63 | 26244 | 28773 | 22574 | 3171 |
| 62 | 24601 | 25615 | 21414 | 2970 |
| 61 | 23151 | 22943 | 20360 | 2798 |
| 60 | 21857 | 20655 | 19395 | 2650 |
| 59 | 20692 | 18677 | 18506 | 2520 |
| 58 | 19635 | 16950 | 17684 | 2405 |
| 57 | 18669 | 15433 | 16919 | 2302 |
| 56 | 17781 | 14091 | 16206 | 2210 |
| 55 | 16961 | 12898 | 15538 | 2127 |
| 54 | 16199 | 11830 | 14910 | 2051 |
| 53 | 15490 | 10871 | 14319 | 1982 |
| 52 | 14827 | 10006 | 13760 | 1918 |
| 51 | 14204 | 9223 | 13230 | 1860 |
| 50 | 13618 | 8512 | 12727 | 1806 |
| 49 | 13064 | 7864 | 12249 | 1756 |
| 48 | 12541 | 7272 | 11792 | 1709 |
| 47 | 12044 | 6729 | 11356 | 1666 |
| 46 | 11571 | 6231 | 10939 | 1626 |
| 45 | 11121 | 5773 | 10539 | 1588 |
| 44 | 10691 | 5350 | 10155 | 1552 |
| 43 | 10279 | 4959 | 9786 | 1519 |
| 42 | 9885 | 4598 | 9430 | 1488 |
| 41 | 9506 | 4263 | 9087 | 1458 |
| 40 | 9142 | 3952 | 8755 | 1431 |

$\lambda = 0{\cdot}10$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 70° | 81218 | 166085 | 42040 | 19221 |
| 69¾ | 69862 | 135118 | 40009 | 13684 |
| 69½ | 63221 | 117242 | 38466 | 11178 |
| 69¼ | 58519 | 104747 | 37181 | 9669 |
| 69 | 54884 | 95214 | 36064 | 8631 |
| 68¾ | 51926 | 87558 | 35067 | 7862 |
| 68½ | 49437 | 81198 | 34163 | 7262 |

## IX. (*continued*).

| $\lambda = 0{\cdot}10$ | | | | | $\lambda = 0{\cdot}10$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $68\frac{1}{4}°$ | 47292 | 75785 | 33333 | 6776 | 39° | 8880 | 3712 | 8476 | 1419 |
| 68 | 45409 | 71094 | 32564 | 6372 | 38 | 8534 | 3437 | 8162 | 1394 |
| $67\frac{3}{4}$ | 43733 | 66972 | 31846 | 6030 | 37 | 8201 | 3182 | 7858 | 1369 |
| $67\frac{1}{2}$ | 42225 | 63308 | 31172 | 5734 | 36 | 7879 | 2943 | 7564 | 1346 |
| $67\frac{1}{4}$ | 40855 | 60021 | 30537 | 5476 | 35 | 7568 | 2721 | 7277 | 1325 |
| 67 | 39601 | 57049 | 29935 | 5248 | 34 | 7267 | 2514 | 6999 | 1304 |
| $66\frac{3}{4}$ | 38446 | 54345 | 29364 | 5044 | 33 | 6974 | 2320 | 6728 | 1285 |
| $66\frac{1}{2}$ | 37377 | 51870 | 28819 | 4861 | 32 | 6690 | 2140 | 6464 | 1266 |
| $66\frac{1}{4}$ | 36382 | 49594 | 28299 | 4694 | 31 | 6414 | 1970 | 6207 | 1249 |
| 66 | 35451 | 47492 | 27801 | 4543 | 30 | 6146 | 1812 | 5955 | 1232 |
| $65\frac{3}{4}$ | 34579 | 45543 | 27324 | 4404 | 29 | 5884 | 1664 | 5710 | 1216 |
| $65\frac{1}{2}$ | 33757 | 43730 | 26865 | 4275 | 28 | 5629 | 1526 | 5470 | 1202 |
| $65\frac{1}{4}$ | 32982 | 42039 | 26424 | 4157 | 27 | 5380 | 1396 | 5235 | 1187 |
| 65 | 32248 | 40456 | 25999 | 4047 | 26 | 5137 | 1275 | 5005 | 1174 |
| 64 | 29657 | 35018 | 24436 | 3673 | 25 | 4899 | 1162 | 4779 | 1161 |
| 63 | 27492 | 30673 | 23059 | 3379 | 24 | 4667 | 1056 | 4558 | 1149 |
| 62 | 25642 | 27117 | 21828 | 3139 | 23 | 4439 | 956·4 | 4340 | 1137 |
| 61 | 24033 | 24152 | 20717 | 2939 | 22 | 4215 | 863·8 | 4126 | 1126 |
| 60 | 22613 | 21641 | 19706 | 2769 | 21 | 3996 | 777·4 | 3916 | 1116 |
| 59 | 21347 | 19491 | 18780 | 2621 | 20 | 3781 | 696·9 | 3709 | 1106 |
| 58 | 20207 | 17629 | 17926 | 2493 | 19 | 3569 | 621·9 | 3505 | 1097 |
| 57 | 19172 | 16004 | 17135 | 2379 | 18 | 3361 | 552·2 | 3304 | 1088 |
| 56 | 18226 | 14575 | 16399 | 2278 | 17 | 3156 | 487·5 | 3106 | 1080 |
| 55 | 17357 | 13310 | 15711 | 2187 | 16 | 2954 | 427·7 | 2910 | 1072 |
| 54 | 16554 | 12183 | 15067 | 2105 | 15 | 2755 | 372·4 | 2717 | 1065 |
| 53 | 15808 | 11176 | 14460 | 2030 | 14 | 2558 | 321·6 | 2525 | 1058 |
| 52 | 15113 | 10270 | 13888 | 1962 | 13 | 2364 | 275·0 | 2336 | 1051 |
| 51 | 14463 | 9452 | 13347 | 1899 | 12 | 2172 | 232·5 | 2149 | 1045 |
| 50 | 13853 | 8711 | 12834 | 1842 | 11 | 1983 | 194·0 | 1963 | 1039 |
| 49 | 13278 | 8038 | 12346 | 1790 | 10 | 1795 | 159·2 | 1779 | 1034 |
| 48 | 12735 | 7424 | 11881 | 1739 | 9 | 1610 | 128·2 | 1596 | 1029 |
| 47 | 12221 | 6863 | 11438 | 1694 | 8 | 1426 | 100·7 | 1415 | 1024 |
| 46 | 11733 | 6349 | 11014 | 1651 | 7 | 1243 | 76·6 | 1235 | 1020 |
| 45 | 11269 | 5876 | 10608 | 1612 | 6 | 1062 | 56·0 | 1057 | 1016 |
| 44 | 10826 | 5441 | 10218 | 1574 | 5 | 883 | 38·7 | 879 | 1013 |
| 43 | 10403 | 5040 | 9843 | 1539 | 4 | 704 | 24·7 | 702 | 1010 |
| 42 | 9999 | 4669 | 9483 | 1506 | 3 | 527 | 13·8 | 526 | 1007 |
| 41 | 9611 | 4326 | 9135 | 1476 | 2 | 351 | 6·1 | 350 | 1004 |
| 40 | 9238 | 4007 | 8800 | 1447 | +1 | 175 | 1·5 | 175 | 1002 |

IX. (*continued*).

| $\lambda = 0{\cdot}10$ | | | | | $\lambda = 0{\cdot}10$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 0 | 0 | 0 | 0 | 1000 | 40° | 7727 | 3150 | 8050 | 1199 |
| − 1° | 174 | 1·5 | 174 | 998 | 41 | 7981 | 3367 | 8326 | 1213 |
| 2 | 348 | 6·1 | 349 | 997 | 42 | 8241 | 3597 | 8611 | 1227 |
| 3 | 521 | 13·6 | 523 | 996 | | | | | |
| | | | | | 43 | 8507 | 3841 | 8903 | 1243 |
| 4 | 695 | 24·2 | 697 | 996 | 44 | 8780 | 4100 | 9204 | 1259 |
| 5 | 867 | 37·8 | 871 | 995 | 45 | 9060 | 4375 | 9514 | 1275 |
| 6 | 1040 | 54·5 | 1046 | 995 | | | | | |
| | | | | | 46 | 9348 | 4668 | 9834 | 1293 |
| 7 | 1213 | 74·2 | 1221 | 995 | 47 | 9644 | 4980 | 10164 | 1311 |
| 8 | 1386 | 96·9 | 1396 | 996 | 48 | 9948 | 5312 | 10505 | 1331 |
| 9 | 1559 | 122·8 | 1572 | 997 | | | | | |
| | | | | | 49 | 10262 | 5667 | 10858 | 1351 |
| 10 | 1733 | 151·9 | 1748 | 998 | 50 | 10585 | 6046 | 11224 | 1372 |
| 11 | 1907 | 184·1 | 1925 | 999 | 51 | 10919 | 6450 | 11603 | 1393 |
| 12 | 2082 | 219·7 | 2103 | 1001 | | | | | |
| | | | | | 52 | 11263 | 6884 | 11997 | 1417 |
| 13 | 2257 | 258·5 | 2283 | 1003 | 53 | 11620 | 7348 | 12407 | 1441 |
| 14 | 2433 | 300·8 | 2463 | 1006 | 54 | 11988 | 7846 | 12833 | 1466 |
| 15 | 2610 | 346·6 | 2644 | 1008 | | | | | |
| | | | | | 55 | 12370 | 8382 | 13278 | 1493 |
| 16 | 2788 | 395·9 | 2827 | 1011 | 56 | 12766 | 8958 | 13742 | 1520 |
| 17 | 2967 | 449·0 | 3012 | 1015 | 57 | 13177 | 9579 | 14228 | 1549 |
| 18 | 3147 | 505·8 | 3198 | 1018 | | | | | |
| | | | | | 58 | 13604 | 10250 | 14736 | 1580 |
| 19 | 3329 | 566·6 | 3385 | 1022 | 59 | 14049 | 10975 | 15269 | 1612 |
| 20 | 3512 | 631·5 | 3575 | 1027 | 60 | 14512 | 11761 | 15829 | 1645 |
| 21 | 3697 | 700·6 | 3767 | 1031 | | | | | |
| | | | | | 61 | 14994 | 12614 | 16418 | 1680 |
| 22 | 3884 | 774·1 | 3961 | 1036 | 62 | 15497 | 13541 | 17039 | 1717 |
| 23 | 4072 | 852·1 | 4157 | 1042 | 63 | 16023 | 14552 | 17696 | 1755 |
| 24 | 4263 | 935·0 | 4356 | 1048 | | | | | |
| | | | | | 64 | 16573 | 15655 | 18390 | 1795 |
| 25 | 4455 | 1023 | 4557 | 1054 | 65 | 17149 | 16863 | 19127 | 1838 |
| 26 | 4650 | 1116 | 4762 | 1060 | 66 | 17752 | 18188 | 19909 | 1882 |
| 27 | 4848 | 1214 | 4969 | 1067 | | | | | |
| | | | | | 67 | 18386 | 19644 | 20743 | 1928 |
| 28 | 5048 | 1318 | 5180 | 1074 | 68 | 19051 | 21250 | 21634 | 1976 |
| 29 | 5251 | 1429 | 5394 | 1082 | 69 | 19750 | 23026 | 22587 | 2027 |
| 30 | 5457 | 1545 | 5612 | 1090 | | | | | |
| | | | | | 70 | 20485 | 24994 | 23611 | 2080 |
| 31 | 5666 | 1668 | 5834 | 1099 | 71 | 21260 | 27183 | 24713 | 2134 |
| 32 | 5878 | 1798 | 6059 | 1108 | 72 | 22077 | 29625 | 25903 | 2192 |
| 33 | 6095 | 1936 | 6290 | 1117 | | | | | |
| | | | | | 73 | 22938 | 32357 | 27192 | 2251 |
| 34 | 6314 | 2082 | 6525 | 1127 | 74 | 23846 | 35426 | 28595 | 2312 |
| 35 | 6538 | 2236 | 6765 | 1138 | 75 | 24805 | 38886 | 30127 | 2376 |
| 36 | 6767 | 2398 | 7010 | 1149 | | | | | |
| | | | | | 76 | 25818 | 42804 | 31806 | 2441 |
| 37 | 6999 | 2571 | 7264 | 1161 | 77 | 26886 | 47258 | 33657 | 2508 |
| 38 | 7237 | 2753 | 7517 | 1173 | 78 | 28014 | 52347 | 35708 | 2575 |
| 39 | 7479 | 2946 | 7780 | 1185 | 79 | 29202 | 58195 | 37994 | 2644 |
| | | | | | 80 | 30454 | 64955 | 40561 | 2712 |

IX. (*continued*).

| $\lambda = 0{\cdot}11$ | | | | | $\lambda = 0{\cdot}12$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $68\frac{1}{4}°$ | 57839 | 99473 | 35819 | 9888 | 67° | 52928 | 84598 | 33410 | 8758 |
| 68 | 54069 | 90087 | 34731 | 8752 | $66\frac{3}{4}$ | 49912 | 77534 | 32487 | 7905 |
| $67\frac{3}{4}$ | 51047 | 82651 | 33768 | 7927 | $66\frac{1}{2}$ | 47412 | 71749 | 31655 | 7256 |
| $67\frac{1}{2}$ | 48527 | 76529 | 32897 | 7292 | $66\frac{1}{4}$ | 45280 | 66874 | 30894 | 6740 |
| $67\frac{1}{4}$ | 46370 | 71353 | 32099 | 6785 | 66 | 43424 | 62679 | 30191 | 6316 |
| 67 | 44487 | 66888 | 31362 | 6366 | $65\frac{3}{4}$ | 41782 | 59012 | 29536 | 5960 |
| $66\frac{3}{4}$ | 42817 | 62978 | 30675 | 6014 | $65\frac{1}{2}$ | 40311 | 55766 | 28922 | 5656 |
| $66\frac{1}{2}$ | 41319 | 59511 | 30030 | 5711 | $65\frac{1}{4}$ | 38981 | 52864 | 28344 | 5392 |
| $66\frac{1}{4}$ | 39962 | 56409 | 29423 | 5448 | 65 | 37767 | 50246 | 27797 | 5160 |
| 66 | 38723 | 53608 | 28849 | 5215 | $64\frac{3}{4}$ | 36652 | 47868 | 27277 | 4953 |
| $65\frac{3}{4}$ | 37583 | 51064 | 28303 | 5009 | $64\frac{1}{2}$ | 35622 | 45696 | 26782 | 4768 |
| $65\frac{1}{2}$ | 36529 | 48737 | 27784 | 4823 | $64\frac{1}{4}$ | 34665 | 43700 | 26310 | 4601 |
| $65\frac{1}{4}$ | 35549 | 46600 | 27287 | 4656 | 64 | 33772 | 41858 | 25858 | 4449 |
| 65 | 34635 | 44627 | 26813 | 4503 | $63\frac{3}{4}$ | 32935 | 40152 | 25424 | 4311 |
| $64\frac{3}{4}$ | 33778 | 42799 | 26357 | 4363 | $63\frac{1}{2}$ | 32148 | 38565 | 25007 | 4183 |
| $64\frac{1}{2}$ | 32971 | 41099 | 25919 | 4235 | $63\frac{1}{4}$ | 31406 | 37085 | 24605 | 4065 |
| $64\frac{1}{4}$ | 32211 | 39514 | 25498 | 4116 | 63 | 30704 | 35701 | 24218 | 3956 |
| 64 | 31492 | 38030 | 25092 | 4006 | 62 | 28230 | 30944 | 22795 | 3587 |
| 63 | 28954 | 32937 | 23601 | 3633 | 61 | 26167 | 27142 | 21537 | 3298 |
| 62 | 26837 | 28867 | 22284 | 3341 | 60 | 24405 | 24025 | 20411 | 3063 |
| 61 | 25029 | 25535 | 21107 | 3103 | 59 | 22872 | 21422 | 19392 | 2868 |
| 60 | 23456 | 22754 | 20043 | 2905 | 58 | 21520 | 19214 | 18462 | 2702 |
| 59 | 22070 | 20399 | 19074 | 2736 | 57 | 20314 | 17319 | 17608 | 2559 |
| 58 | 20833 | 18379 | 18185 | 2591 | 56 | 19227 | 15676 | 16818 | 2434 |
| 57 | 19718 | 16630 | 17364 | 2464 | 55 | 18239 | 14239 | 16086 | 2324 |
| 56 | 18707 | 15101 | 16602 | 2352 | 54 | 17336 | 12973 | 15403 | 2226 |
| 55 | 17783 | 13755 | 15893 | 2252 | 53 | 16506 | 11850 | 14762 | 2138 |
| 54 | 16932 | 12563 | 15230 | 2163 | 52 | 15738 | 10849 | 14160 | 2059 |
| 53 | 16147 | 11501 | 14607 | 2082 | 51 | 15024 | 9952 | 13593 | 1986 |
| 52 | 15417 | 10550 | 14021 | 2008 | 50 | 14359 | 9144 | 13057 | 1920 |
| 51 | 14737 | 9694 | 13467 | 1941 | 49 | 13735 | 8414 | 12550 | 1860 |
| 50 | 14100 | 8921 | 12943 | 1880 | 48 | 13150 | 7752 | 12067 | 1805 |
| 49 | 13501 | 8221 | 12446 | 1823 | 47 | 12597 | 7149 | 11607 | 1753 |
| 48 | 12938 | 7584 | 11972 | 1771 | 46 | 12076 | 6599 | 11169 | 1706 |
| 47 | 12406 | 7003 | 11521 | 1723 | 45 | 11581 | 6096 | 10750 | 1662 |
| 46 | 11901 | 6471 | 11090 | 1678 | 44 | 11111 | 5634 | 10348 | 1620 |
| 45 | 11422 | 5983 | 10678 | 1636 | 43 | 10664 | 5209 | 9963 | 1582 |
| 44 | 10967 | 5535 | 10282 | 1597 | 42 | 10237 | 4818 | 9593 | 1546 |
| 43 | 10532 | 5123 | 9902 | 1560 | 41 | 9829 | 4457 | 9237 | 1513 |
| 42 | 10116 | 4742 | 9537 | 1526 | 40 | 9438 | 4123 | 8893 | 1481 |
| 41 | 9719 | 4390 | 9185 | 1494 | | | | | |
| 40 | 9337 | 4064 | 8846 | 1464 | | | | | |

IX. (*continued*).

| $\lambda = 0{\cdot}13$ | | | | | $\lambda = 0{\cdot}14$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 66° | 51486 | 78857 | 32101 | 8648 | 65° | 49792 | 73004 | 30811 | 8435 |
| 65⅞ | 48547 | 72293 | 31226 | 7802 | 64⅞ | 46991 | 67031 | 29988 | 7620 |
| 65½ | 46115 | 66923 | 30436 | 7156 | 64½ | 44667 | 62130 | 29245 | 6998 |
| 65¼ | 44042 | 62400 | 29715 | 6644 | 64¼ | 42683 | 57993 | 28565 | 6503 |
| 65 | 42239 | 58510 | 29048 | 6225 | 64 | 40954 | 54428 | 27936 | 6097 |
| 64⅞ | 40644 | 55110 | 28427 | 5873 | 63⅞ | 39424 | 51307 | 27349 | 5756 |
| 64½ | 39217 | 52100 | 27844 | 5573 | 63½ | 38052 | 48540 | 26798 | 5464 |
| 64¼ | 37925 | 49407 | 27296 | 5312 | 63¼ | 36810 | 46062 | 26279 | 5211 |
| 64 | 36747 | 46979 | 26776 | 5083 | 63 | 35676 | 43825 | 25787 | 4988 |
| 63⅞ | 35665 | 44773 | 26283 | 4879 | 62⅞ | 34634 | 41790 | 25319 | 4790 |
| 63½ | 34666 | 42756 | 25813 | 4697 | 62½ | 33670 | 39929 | 24873 | 4612 |
| 63¼ | 33737 | 40903 | 25363 | 4533 | 62¼ | 32775 | 38217 | 24447 | 4452 |
| 63 | 32870 | 39192 | 24933 | 4383 | 62 | 31938 | 36636 | 24038 | 4306 |
| 62⅞ | 32058 | 37607 | 24520 | 4247 | 61⅞ | 31154 | 35170 | 23646 | 4173 |
| 62½ | 31294 | 36133 | 24123 | 4121 | 61½ | 30417 | 33804 | 23269 | 4050 |
| 62¼ | 30574 | 34757 | 23741 | 4005 | 61¼ | 29721 | 32530 | 22905 | 3937 |
| 62 | 29893 | 33469 | 23372 | 3898 | 61 | 29063 | 31336 | 22554 | 3832 |
| 61 | 27491 | 29041 | 22015 | 3535 | 60 | 26739 | 27225 | 21261 | 3478 |
| 60 | 25487 | 25496 | 20814 | 3251 | 59 | 24798 | 23928 | 20114 | 3200 |
| 59 | 23774 | 22586 | 19737 | 3021 | 58 | 23137 | 21216 | 19083 | 2975 |
| 58 | 22283 | 20152 | 18761 | 2829 | 57 | 21690 | 18944 | 18148 | 2788 |
| 57 | 20967 | 18086 | 17869 | 2666 | 56 | 20412 | 17011 | 17292 | 2628 |
| 56 | 19792 | 16310 | 17048 | 2526 | 55 | 19269 | 15349 | 16503 | 2491 |
| 55 | 18733 | 14769 | 16289 | 2403 | 54 | 18239 | 13903 | 15773 | 2371 |
| 54 | 17771 | 13419 | 15583 | 2295 | 53 | 17301 | 12636 | 15093 | 2265 |
| 53 | 16890 | 12228 | 14924 | 2199 | 52 | 16443 | 11517 | 14457 | 2171 |
| 52 | 16079 | 11171 | 14306 | 2113 | 51 | 15653 | 10523 | 13860 | 2087 |
| 51 | 15329 | 10228 | 13725 | 2035 | 50 | 14921 | 9635 | 13298 | 2010 |
| 50 | 14632 | 9382 | 13176 | 1964 | 49 | 14240 | 8837 | 12768 | 1941 |
| 49 | 13981 | 8620 | 12657 | 1899 | 48 | 13604 | 8118 | 12265 | 1878 |
| 48 | 13371 | 7930 | 12165 | 1840 | 47 | 13008 | 7467 | 11787 | 1820 |
| 47 | 12798 | 7304 | 11697 | 1785 | 46 | 12447 | 6876 | 11333 | 1766 |
| 46 | 12257 | 6734 | 11250 | 1735 | 45 | 11918 | 6338 | 10899 | 1717 |
| 45 | 11746 | 6214 | 10824 | 1688 | 44 | 11417 | 5846 | 10485 | 1671 |
| 44 | 11261 | 5738 | 10416 | 1645 | 43 | 10942 | 5395 | 10088 | 1629 |
| 43 | 10801 | 5300 | 10025 | 1605 | 42 | 10491 | 4981 | 9707 | 1589 |
| 42 | 10362 | 4898 | 9650 | 1567 | 41 | 10060 | 4600 | 9341 | 1552 |
| 41 | 9943 | 4527 | 9289 | 1532 | 40 | 9649 | 4249 | 8989 | 1518 |
| 40 | 9542 | 4185 | 8941 | 1499 | | | | | |

IX. (*continued*).

| $\lambda = 0{\cdot}15$ | | | | | $\lambda = 0{\cdot}15$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $64\frac{1}{2}°$ | 55459 | 82861 | 31412 | 10758 | 43° | 8164 | 3634 | 8719 | 1192 |
| $64\frac{1}{4}$ | 51164 | 73902 | 30412 | 9185 | 44 | 8415 | 3872 | 9007 | 1205 |
| 64 | 47909 | 67189 | 29549 | 8139 | 45 | 8671 | 4124 | 9304 | 1220 |
| $63\frac{3}{4}$ | 45292 | 61852 | 28782 | 7379 | 46 | 8934 | 4392 | 9610 | 1235 |
| $63\frac{1}{2}$ | 43107 | 57444 | 28087 | 6794 | 47 | 9204 | 4676 | 9925 | 1250 |
| $63\frac{1}{4}$ | 41233 | 53707 | 27449 | 6326 | 48 | 9480 | 4977 | 10250 | 1266 |
| 63 | 39595 | 50473 | 26858 | 5940 | 49 | 9764 | 5298 | 10586 | 1283 |
| $62\frac{3}{4}$ | 38140 | 47634 | 26305 | 5614 | 50 | 10055 | 5639 | 10933 | 1301 |
| $62\frac{1}{2}$ | 36834 | 45111 | 25786 | 5335 | 51 | 10355 | 6003 | 11292 | 1320 |
| $62\frac{1}{4}$ | 35649 | 42847 | 25296 | 5091 | 52 | 10663 | 6390 | 11665 | 1339 |
| 62 | 34566 | 40799 | 24831 | 4877 | 53 | 10981 | 6804 | 12052 | 1359 |
| $61\frac{3}{4}$ | 33569 | 38933 | 24388 | 4687 | 54 | 11308 | 7247 | 12454 | 1380 |
| $61\frac{1}{2}$ | 32646 | 37224 | 23966 | 4515 | 55 | 11546 | 7720 | 12872 | 1402 |
| $61\frac{1}{4}$ | 31787 | 35650 | 23562 | 4360 | 56 | 11994 | 8227 | 13307 | 1425 |
| 61 | 30984 | 34195 | 23174 | 4220 | 57 | 12354 | 8772 | 13762 | 1449 |
| 60 | 28220 | 29304 | 21764 | 3761 | 58 | 12727 | 9356 | 14236 | 1473 |
| 59 | 25979 | 25498 | 20533 | 3417 | 59 | 13112 | 9986 | 14733 | 1499 |
| 58 | 24104 | 22436 | 19437 | 3147 | 60 | 13512 | 10664 | 15253 | 1526 |
| 57 | 22498 | 19912 | 18451 | 2927 | 61 | 13926 | 11396 | 15799 | 1554 |
| 56 | 21096 | 17794 | 17555 | 2745 | 62 | 14356 | 12187 | 16373 | 1584 |
| 55 | 19856 | 15989 | 16734 | 2589 | 63 | 14802 | 13045 | 16978 | 1614 |
| 54 | 18748 | 14433 | 15976 | 2455 | 64 | 15265 | 13975 | 17615 | 1645 |
| 53 | 17745 | 13079 | 15273 | 2338 | 65 | 15747 | 14986 | 18289 | 1679 |
| 52 | 16833 | 11890 | 14618 | 2235 | 66 | 16249 | 16087 | 19003 | 1713 |
| 51 | 15998 | 10839 | 14004 | 2143 | 67 | 16772 | 17289 | 19760 | 1748 |
| 50 | 15227 | 9905 | 13428 | 2060 | 68 | 17316 | 18605 | 20566 | 1785 |
| 49 | 14514 | 9069 | 12884 | 1985 | 69 | 17884 | 20047 | 21425 | 1823 |
| 48 | 13849 | 8318 | 12370 | 1918 | 70 | 18477 | 21632 | 22344 | 1862 |
| 47 | 13228 | 7640 | 11883 | 1856 | 71 | 19095 | 23379 | 23328 | 1903 |
| 46 | 12646 | 7026 | 11420 | 1799 | 72 | 19741 | 25310 | 24387 | 1944 |
| 45 | 12098 | 6468 | 10979 | 1747 | 73 | 20415 | 27450 | 25528 | 1987 |
| 44 | 11580 | 5959 | 10557 | 1698 | 74 | 21120 | 29828 | 26763 | 2031 |
| 43 | 11090 | 5494 | 10154 | 1654 | 75 | 21855 | 32482 | 28104 | 2075 |
| 42 | 10625 | 5067 | 9767 | 1612 | 76 | 22623 | 35453 | 29567 | 2120 |
| 41 | 10182 | 4676 | 9396 | 1573 | 77 | 23424 | 38794 | 31170 | 2166 |
| 40 | 9760 | 4315 | 9039 | 1537 | 78 | 24260 | 42567 | 32935 | 2211 |
| + | ..... | ..... | ..... | ..... | | | | | |
| 0 | 0 | 0 | 0 | 1000 | 79 | 25131 | 46851 | 34892 | 2256 |
| − | ..... | ..... | ..... | ..... | 80 | 26037 | 51746 | 37077 | 2301 |
| 40 | 7444 | 2996 | 7899 | 1154 | | | | | |
| 41 | 7679 | 3197 | 8165 | 1166 | | | | | |
| 42 | 7919 | 3409 | 8438 | 1179 | | | | | |

IX. (*continued*).

| $\lambda = 0{\cdot}16$ | | | | | $\lambda = 0{\cdot}17$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 63° | 45906 | 61547 | 28320 | 7786 | 62½° | 49842 | 67590 | 28682 | 9367 |
| 62¾ | 43499 | 56847 | 27610 | 7095 | 62¼ | 46493 | 61188 | 27858 | 8216 |
| 62½ | 41472 | 52931 | 26963 | 6556 | 62 | 43844 | 56179 | 27132 | 7401 |
| 62¼ | 39722 | 49588 | 26367 | 6121 | 61¾ | 41656 | 52085 | 26476 | 6783 |
| 62 | 38185 | 46681 | 25813 | 5759 | 61½ | 39795 | 48638 | 25877 | 6295 |
| 61¾ | 36815 | 44118 | 25295 | 5453 | 61¼ | 38176 | 45672 | 25322 | 5897 |
| 61½ | 35581 | 41833 | 24806 | 5189 | 61 | 36746 | 43078 | 24805 | 5563 |
| 61¼ | 34459 | 39776 | 24344 | 4958 | 60¾ | 35465 | 40779 | 24319 | 5278 |
| 61 | 33430 | 37912 | 23906 | 4754 | 60½ | 34307 | 38722 | 23861 | 5031 |
| 60¾ | 32482 | 36209 | 23488 | 4573 | 60¼ | 33250 | 36863 | 23427 | 4814 |
| 60½ | 31602 | 34647 | 23088 | 4409 | 60 | 32280 | 35173 | 23013 | 4622 |
| 60¼ | 30783 | 33206 | 22706 | 4261 | 59¾ | 31382 | 33627 | 22619 | 4450 |
| 60 | 30016 | 31871 | 22339 | 4125 | 59½ | 30548 | 32204 | 22242 | 4295 |
| 59¾ | 29296 | 30630 | 21986 | 4002 | 59¼ | 29770 | 30889 | 21880 | 4154 |
| 59½ | 28617 | 29472 | 21645 | 3887 | 59 | 29040 | 29669 | 21532 | 4026 |
| 59¼ | 27976 | 28388 | 21317 | 3782 | 58 | 26512 | 25540 | 20261 | 3604 |
| 59 | 27368 | 27371 | 20999 | 3684 | 57 | 24449 | 22299 | 19145 | 3284 |
| 58 | 25215 | 23855 | 19826 | 3352 | 56 | 22712 | 19673 | 18147 | 3032 |
| 57 | 23408 | 21018 | 18781 | 3093 | 55 | 21217 | 17497 | 17245 | 2826 |
| 56 | 21857 | 18673 | 17838 | 2878 | 54 | 19909 | 15662 | 16422 | 2654 |
| 55 | 20502 | 16700 | 16980 | 2700 | 53 | 18747 | 14091 | 15665 | 2508 |
| 54 | 19301 | 15016 | 16191 | 2549 | 52 | 17705 | 12733 | 14965 | 2381 |
| 53 | 18225 | 13562 | 15463 | 2419 | 51 | 16762 | 11547 | 14313 | 2270 |
| 52 | 17253 | 12294 | 14786 | 2305 | 50 | 15902 | 10503 | 13704 | 2172 |
| 51 | 16367 | 11179 | 14154 | 2204 | 49 | 15112 | 9577 | 13132 | 2085 |
| 50 | 15554 | 10193 | 13562 | 2114 | 48 | 14382 | 8752 | 12593 | 2006 |
| 49 | 14804 | 9314 | 13005 | 2033 | 47 | 13705 | 8013 | 12084 | 1935 |
| 48 | 14108 | 8528 | 12479 | 1960 | 46 | 13073 | 7347 | 11602 | 1870 |
| 47 | 13460 | 7821 | 11981 | 1894 | 45 | 12482 | 6746 | 11144 | 1811 |
| 46 | 12854 | 7182 | 11509 | 1834 | 44 | 11927 | 6200 | 10707 | 1757 |
| 45 | 12285 | 6603 | 11059 | 1778 | 43 | 11403 | 5703 | 10290 | 1707 |
| 44 | 11750 | 6076 | 10630 | 1727 | 42 | 10909 | 5250 | 9892 | 1661 |
| 43 | 11243 | 5596 | 10221 | 1680 | 41 | 10440 | 4835 | 9510 | 1618 |
| 42 | 10764 | 5156 | 9828 | 1636 | 40 | 9994 | 4454 | 9143 | 1578 |
| 41 | 10309 | 4753 | 9452 | 1595 | | | | | |
| 40 | 9875 | 4383 | 9090 | 1557 | | | | | |

IX. (*continued*).

| $\lambda = 0{\cdot}18$ | | | | | $\lambda = 0{\cdot}19$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $61\frac{1}{4}^\circ$ | 44123 | 55419 | 26650 | 7705 | $60\frac{3}{4}^\circ$ | 47499 | 60177 | 26921 | 9115 |
| 61 | 41775 | 51154 | 25987 | 7003 | $60\frac{1}{2}$ | 44326 | 54540 | 26163 | 7999 |
| $60\frac{3}{4}$ | 39804 | 47615 | 25384 | 6459 | $60\frac{1}{4}$ | 41815 | 50122 | 25493 | 7207 |
| $60\frac{1}{2}$ | 38107 | 44601 | 24830 | 6023 | 60 | 39739 | 46508 | 24889 | 6608 |
| $60\frac{1}{4}$ | 36621 | 41986 | 24314 | 5662 | $59\frac{3}{4}$ | 37972 | 43462 | 24336 | 6134 |
| 60 | 35298 | 39684 | 23832 | 5357 | $59\frac{1}{2}$ | 36434 | 40839 | 23824 | 5747 |
| $59\frac{3}{4}$ | 34108 | 37632 | 23378 | 5094 | $59\frac{1}{4}$ | 35075 | 38543 | 23346 | 5423 |
| $59\frac{1}{2}$ | 33026 | 35787 | 22949 | 4866 | 59 | 33858 | 36507 | 22897 | 5146 |
| $59\frac{1}{4}$ | 32037 | 34115 | 22541 | 4664 | $58\frac{3}{4}$ | 32757 | 34683 | 22473 | 4906 |
| 59 | 31124 | 32589 | 22152 | 4484 | $58\frac{1}{2}$ | 31752 | 33035 | 22070 | 4696 |
| $58\frac{3}{4}$ | 30279 | 31189 | 21780 | 4323 | $58\frac{1}{4}$ | 30828 | 31534 | 21688 | 4509 |
| $58\frac{1}{2}$ | 29491 | 29897 | 21424 | 4177 | 58 | 29974 | 30161 | 21322 | 4342 |
| $58\frac{1}{4}$ | 28754 | 28701 | 21082 | 4043 | $57\frac{3}{4}$ | 29180 | 28896 | 20972 | 4192 |
| 58 | 28063 | 27588 | 20753 | 3922 | $57\frac{1}{2}$ | 28438 | 27726 | 20636 | 4055 |
| 57 | 25657 | 23809 | 19547 | 3520 | $57\frac{1}{4}$ | 27743 | 26641 | 20313 | 3930 |
| 56 | 23684 | 20826 | 18484 | 3215 | 57 | 27089 | 25629 | 20002 | 3815 |
| 55 | 22018 | 18400 | 17532 | 2972 | 56 | 24806 | 22176 | 18858 | 3435 |
| 54 | 20580 | 16383 | 16670 | 2774 | 55 | 22923 | 19435 | 17846 | 3144 |
| 53 | 19318 | 14677 | 15880 | 2608 | 54 | 21327 | 17196 | 16937 | 2911 |
| 52 | 18196 | 13214 | 15154 | 2466 | 53 | 19945 | 15328 | 16112 | 2721 |
| 51 | 17188 | 11946 | 14480 | 2343 | 52 | 18730 | 13744 | 15355 | 2560 |
| 50 | 16274 | 10837 | 13852 | 2235 | 51 | 17648 | 12382 | 14657 | 2423 |
| 49 | 15439 | 9860 | 13264 | 2140 | 50 | 16673 | 11200 | 14009 | 2305 |
| 48 | 14672 | 8992 | 12712 | 2055 | 49 | 15788 | 10163 | 13404 | 2200 |
| 47 | 13962 | 8217 | 12191 | 1978 | 48 | 14979 | 9248 | 12836 | 2108 |
| 46 | 13303 | 7522 | 11698 | 1909 | 47 | 14234 | 8435 | 12303 | 2025 |
| 45 | 12688 | 6896 | 11231 | 1846 | 46 | 13545 | 7708 | 11799 | 1951 |
| 44 | 12112 | 6330 | 10786 | 1789 | 45 | 12904 | 7056 | 11321 | 1883 |
| 43 | 11570 | 5816 | 10362 | 1736 | 44 | 12305 | 6467 | 10868 | 1822 |
| 42 | 11059 | 5347 | 9957 | 1687 | 43 | 11743 | 5934 | 10436 | 1766 |
| 41 | 10576 | 4920 | 9569 | 1642 | 42 | 11215 | 5450 | 10025 | 1714 |
| 40 | 10117 | 4528 | 9197 | 1600 | 41 | 10716 | 5008 | 9631 | 1667 |
| | | | | | 40 | 10244 | 4605 | 9253 | 1623 |

IX. (*continued*).

| $\lambda = 0{\cdot}20$ | | | | | $\lambda = 0{\cdot}20$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 60° | 47859 | 59443 | 26438 | 9557 | 30° | 6592 | 1991 | 6165 | 1327 |
| 59½ | 44421 | 53516 | 25667 | 8272 | 29 | 6290 | 1820 | 5901 | 1305 |
| 59 | 41759 | 48973 | 24993 | 7390 | 28 | 5997 | 1661 | 5643 | 1285 |
| 58½ | 39590 | 45308 | 24389 | 6736 | 27 | 5714 | 1513 | 5393 | 1265 |
| 59 | 37761 | 42249 | 23839 | 6227 | 26 | 5439 | 1376 | 5148 | 1246 |
| 58½ | 36182 | 39633 | 23331 | 5816 | 25 | 5172 | 1249 | 4909 | 1228 |
| 58½ | 34794 | 37356 | 22858 | 5474 | 24 | 4912 | 1130 | 4675 | 1212 |
| 58 | 33556 | 35345 | 22415 | 5185 | 23 | 4659 | 1020 | 4446 | 1196 |
| 58 | 32439 | 33550 | 21997 | 4936 | 22 | 4413 | 918·3 | 4221 | 1181 |
| 57½ | 31424 | 31932 | 21601 | 4718 | 21 | 4172 | 823·5 | 4001 | 1167 |
| 57½ | 30492 | 30463 | 21225 | 4525 | 20 | 3937 | 735·7 | 3785 | 1153 |
| 57½ | 29633 | 29121 | 20865 | 4353 | 19 | 3708 | 654·4 | 3572 | 1141 |
| 57 | 28835 | 27887 | 20522 | 4199 | 18 | 3483 | 579·2 | 3364 | 1129 |
| 56 | 26123 | 23787 | 19276 | 3707 | 17 | 3263 | 509·8 | 3158 | 1117 |
| 55 | 23960 | 20638 | 18191 | 3348 | 16 | 3047 | 445·9 | 2956 | 1107 |
| 54 | 22168 | 18122 | 17228 | 3071 | 15 | 2835 | 387·1 | 2756 | 1096 |
| 53 | 20641 | 16058 | 16360 | 2850 | 14 | 2627 | 333·3 | 2559 | 1087 |
| 52 | 19316 | 14330 | 15570 | 2667 | 13 | 2423 | 284·2 | 2365 | 1078 |
| 51 | 18147 | 12860 | 14845 | 2511 | 12 | 2222 | 239·7 | 2173 | 1069 |
| 50 | 17103 | 11593 | 14174 | 2381 | 11 | 2024 | 199·4 | 1983 | 1061 |
| 49 | 16162 | 10491 | 13550 | 2266 | 10 | 1829 | 163·2 | 1796 | 1054 |
| 48 | 15306 | 9523 | 12966 | 2165 | 9 | 1636 | 131·0 | 1610 | 1046 |
| 47 | 14522 | 8667 | 12419 | 2075 | 8 | 1447 | 102·6 | 1426 | 1040 |
| 46 | 13799 | 7905 | 11903 | 1995 | 7 | 1259 | 77·9 | 1243 | 1033 |
| 45 | 13130 | 7224 | 11415 | 1923 | 6 | 1074 | 56·8 | 1062 | 1027 |
| 44 | 12506 | 6611 | 10953 | 1858 | 5 | 891 | 39·2 | 883 | 1022 |
| 43 | 11924 | 6058 | 10513 | 1798 | 4 | 709 | 24·9 | 704 | 1017 |
| 42 | 11377 | 5557 | 10094 | 1743 | 3 | 530 | 13·9 | 527 | 1012 |
| 41 | 10862 | 5101 | 9694 | 1693 | 2 | 352 | 6·2 | 351 | 1008 |
| 40 | 10375 | 4685 | 9310 | 1647 | +1 | 175 | 1·5 | 175 | 1004 |
| | | | | | 0 | 0 | 0 | 0 | 1000 |
| 39 | 9914 | 4305 | 8943 | 1604 | −1 | 174 | 1·5 | 174 | 997 |
| 38 | 9476 | 3957 | 8590 | 1564 | 2 | 347 | 6·0 | 348 | 994 |
| 37 | 9059 | 3637 | 8249 | 1527 | 3 | 519 | 13·5 | 521 | 991 |
| 36 | 8661 | 3342 | 7922 | 1493 | 4 | 690 | 24·0 | 694 | 989 |
| 35 | 8281 | 3071 | 7605 | 1461 | 5 | 860 | 37·4 | 867 | 987 |
| 34 | 7916 | 2820 | 7299 | 1431 | 6 | 1029 | 53·7 | 1040 | 985 |
| 33 | 7566 | 2588 | 7002 | 1402 | 7 | 1199 | 73·0 | 1213 | 984 |
| 32 | 7229 | 2374 | 6715 | 1376 | 8 | 1367 | 95·2 | 1386 | 983 |
| 31 | 6905 | 2175 | 6436 | 1351 | 9 | 1536 | 120·4 | 1560 | 982 |

IX. (*continued*).

| $\lambda = 0{\cdot}20$ | | | | | $\lambda = 0{\cdot}20$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 10° | 1704 | 148·5 | 1733 | 981 | 46° | 8567 | 4149 | 9404 | 1184 |
| 11 | 1872 | 179·6 | 1908 | 981 | 47 | 8814 | 4410 | 9705 | 1197 |
| 12 | 2040 | 213·8 | 2082 | 981 | 48 | 9067 | 4686 | 10017 | 1211 |
| 13 | 2208 | 251·1 | 2258 | 982 | 49 | 9326 | 4979 | 10337 | 1225 |
| 14 | 2376 | 291·5 | 2434 | 982 | 50 | 9591 | 5289 | 10669 | 1240 |
| 15 | 2544 | 335·1 | 2611 | 983 | 51 | 9863 | 5619 | 11011 | 1256 |
| 16 | 2713 | 382·0 | 2789 | 985 | 52 | 10142 | 5970 | 11366 | 1273 |
| 17 | 2883 | 432·2 | 2969 | 986 | 53 | 10429 | 6344 | 11733 | 1290 |
| 18 | 3053 | 485·8 | 3149 | 988 | 54 | 10723 | 6741 | 12114 | 1307 |
| 19 | 3224 | 543·0 | 3331 | 990 | 55 | 11026 | 7166 | 12510 | 1326 |
| 20 | 3395 | 603·8 | 3515 | 993 | 56 | 11337 | 7619 | 12921 | 1345 |
| 21 | 3568 | 668·3 | 3700 | 996 | 57 | 11657 | 8103 | 13350 | 1365 |
| 22 | 3741 | 736·7 | 3887 | 999 | 58 | 11988 | 8621 | 13797 | 1386 |
| 23 | 3916 | 809·0 | 4076 | 1002 | 59 | 12328 | 9177 | 14263 | 1408 |
| 24 | 4092 | 885·6 | 4267 | 1006 | 60 | 12679 | 9774 | 14751 | 1430 |
| 25 | 4269 | 966·4 | 4461 | 1010 | 61 | 13042 | 10415 | 15263 | 1453 |
| 26 | 4448 | 1052 | 4656 | 1015 | 62 | 13417 | 11105 | 15799 | 1477 |
| 27 | 4629 | 1142 | 4855 | 1019 | 63 | 13804 | 11849 | 16362 | 1502 |
| 28 | 4811 | 1237 | 5056 | 1024 | 64 | 14205 | 12653 | 16954 | 1528 |
| 29 | 4995 | 1337 | 5260 | 1030 | 65 | 14619 | 13523 | 17579 | 1555 |
| 30 | 5181 | 1442 | 5467 | 1036 | 66 | 15049 | 14465 | 18240 | 1582 |
| 31 | 5370 | 1553 | 5677 | 1042 | 67 | 15494 | 15489 | 18939 | 1611 |
| 32 | 5560 | 1670 | 5891 | 1048 | 68 | 15955 | 16602 | 19680 | 1640 |
| 33 | 5753 | 1793 | 6109 | 1055 | 69 | 16433 | 17817 | 20469 | 1670 |
| 34 | 5949 | 1922 | 6330 | 1062 | 70 | 16929 | 19144 | 21309 | 1701 |
| 35 | 6147 | 2059 | 6556 | 1070 | 71 | 17443 | 20597 | 22207 | 1733 |
| 36 | 6349 | 2202 | 6786 | 1078 | 72 | 17977 | 22194 | 23169 | 1765 |
| 37 | 6553 | 2353 | 7021 | 1087 | 73 | 18531 | 23952 | 24204 | 1798 |
| 38 | 6761 | 2513 | 7261 | 1096 | 74 | 19106 | 25894 | 25319 | 1832 |
| 39 | 6972 | 2681 | 7507 | 1105 | 75 | 19703 | 28046 | 26527 | 1866 |
| 40 | 7187 | 2858 | 7758 | 1115 | 76 | 20321 | 30439 | 27840 | 1900 |
| 41 | 7406 | 3045 | 8015 | 1125 | 77 | 20963 | 33111 | 29274 | 1934 |
| 42 | 7629 | 3242 | 8278 | 1136 | 78 | 21627 | 36109 | 30848 | 1967 |
| 43 | 7856 | 3450 | 8548 | 1147 | 79 | 22314 | 39490 | 32586 | 2001 |
| 44 | 8088 | 3671 | 8826 | 1159 | 80 | 23024 | 43326 | 34520 | 2034 |
| 45 | 8324 | 3903 | 9111 | 1171 | | | | | |

IX. (*continued*).

$\lambda = 0{\cdot}22$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 58° | 41310 | 46280 | 23968 | 7654 |
| 57¾ | 39006 | 42610 | 23372 | 6910 |
| 57½ | 37096 | 39596 | 22833 | 6344 |
| 57¼ | 35465 | 37049 | 22338 | 5895 |
| 57 | 34044 | 34850 | 21879 | 5528 |
| 56¾ | 32786 | 32921 | 21451 | 5220 |
| 56½ | 31657 | 31208 | 21047 | 4956 |
| 56¼ | 30635 | 29671 | 20666 | 4728 |
| 56 | 29701 | 28280 | 20304 | 4528 |
| 55¾ | 28842 | 27012 | 19959 | 4349 |
| 55½ | 28047 | 25850 | 19629 | 4190 |
| 55¼ | 27308 | 24778 | 19313 | 4046 |
| 55 | 26617 | 23787 | 19009 | 3915 |
| 54 | 24235 | 20446 | 17899 | 3491 |
| 53 | 22304 | 17833 | 16923 | 3174 |
| 52 | 20684 | 15721 | 16050 | 2926 |
| 51 | 19292 | 13971 | 15258 | 2726 |
| 50 | 18076 | 12495 | 14534 | 2558 |
| 49 | 16997 | 11231 | 13866 | 2417 |
| 48 | 16030 | 10137 | 13245 | 2295 |
| 47 | 15154 | 9181 | 12667 | 2188 |
| 46 | 14354 | 8338 | 12124 | 2094 |
| 45 | 13620 | 7591 | 11613 | 2010 |
| 44 | 12941 | 6923 | 11131 | 1935 |
| 43 | 12311 | 6325 | 10673 | 1867 |
| 42 | 11722 | 5786 | 10239 | 1806 |
| 41 | 11171 | 5298 | 9825 | 1749 |
| 40 | 10653 | 4855 | 9429 | 1698 |

$\lambda = 0{\cdot}24$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 56¾° | 40352 | 43045 | 22908 | 7735 |
| 56½ | 38012 | 39526 | 22331 | 6944 |
| 56 | 36090 | 36663 | 21812 | 6351 |
| 55¾ | 34461 | 34258 | 21337 | 5885 |
| 55½ | 33048 | 32193 | 20897 | 5507 |
| 55¼ | 31801 | 30387 | 20486 | 5192 |

$\lambda = 0{\cdot}24$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 55° | 30686 | 28787 | 20101 | 4923 |
| 54¾ | 29679 | 27355 | 19736 | 4691 |
| 54½ | 28760 | 26061 | 19390 | 4489 |
| 54¼ | 27917 | 24884 | 19061 | 4309 |
| 54 | 27137 | 23806 | 18746 | 4148 |
| 53¾ | 26412 | 22813 | 18445 | 4004 |
| 53½ | 25736 | 21895 | 18155 | 3872 |
| 53¼ | 25102 | 21042 | 17876 | 3753 |
| 53 | 24506 | 20246 | 17607 | 3643 |
| 52 | 22423 | 17530 | 16617 | 3280 |
| 51 | 20705 | 15369 | 15738 | 3003 |
| 50 | 19247 | 13600 | 14945 | 2783 |
| 49 | 17984 | 12120 | 14222 | 2602 |
| 48 | 16871 | 10861 | 13556 | 2451 |
| 47 | 15879 | 9778 | 12940 | 2321 |
| 46 | 14984 | 8835 | 12366 | 2209 |
| 45 | 14171 | 8007 | 11829 | 2110 |
| 44 | 13426 | 7274 | 11323 | 2023 |
| 43 | 12739 | 6623 | 10846 | 1945 |
| 42 | 12102 | 6039 | 10394 | 1875 |
| 41 | 11510 | 5515 | 9964 | 1812 |
| 40 | 10955 | 5041 | 9555 | 1754 |

$\lambda = 0{\cdot}25$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| – | ..... | ..... | ..... | ..... |
| 40° | 6952 | 2733 | 7627 | 1079 |
| 41 | 7157 | 2908 | 7876 | 1088 |
| 42 | 7365 | 3092 | 8130 | 1097 |
| 43 | 7577 | 3286 | 8391 | 1106 |
| 44 | 7792 | 3491 | 8658 | 1117 |
| 45 | 8012 | 3707 | 8933 | 1127 |
| 46 | 8236 | 3935 | 9215 | 1138 |
| 47 | 8465 | 4176 | 9505 | 1150 |
| 48 | 8698 | 4430 | 9804 | 1162 |
| 49 | 8936 | 4700 | 10112 | 1174 |
| 50 | 9179 | 4985 | 10429 | 1188 |
| 51 | 9428 | 5287 | 10757 | 1201 |

IX. (*continued*).

$\lambda = 0{\cdot}25$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 52° | 9683 | 5607 | 11095 | 1215 |
| 53 | 9944 | 5947 | 11446 | 1230 |
| 54 | 10211 | 6308 | 11809 | 1245 |
| 55 | 10485 | 6693 | 12186 | 1261 |
| 56 | 10767 | 7102 | 12577 | 1278 |
| 57 | 11055 | 7538 | 12984 | 1295 |
| 58 | 11352 | 8004 | 13407 | 1312 |
| 59 | 11657 | 8501 | 13849 | 1331 |
| 60 | 11970 | 9034 | 14310 | 1350 |
| 61 | 12293 | 9604 | 14792 | 1370 |
| 62 | 12625 | 10216 | 15296 | 1390 |
| 63 | 12967 | 10874 | 15826 | 1411 |
| 64 | 13320 | 11581 | 16382 | 1433 |
| 65 | 13684 | 12344 | 16967 | 1455 |
| 66 | 14059 | 13168 | 17585 | 1478 |
| 67 | 14447 | 14059 | 18237 | 1501 |
| 68 | 14846 | 15024 | 18927 | 1526 |
| 69 | 15259 | 16073 | 19660 | 1551 |
| 70 | 15686 | 17214 | 20439 | 1576 |
| 71 | 16126 | 18459 | 21270 | 1602 |
| 72 | 16582 | 19820 | 22159 | 1628 |
| 73 | 17052 | 21312 | 23112 | 1655 |
| 74 | 17538 | 22953 | 24137 | 1682 |
| 75 | 18039 | 24763 | 25245 | 1709 |
| 76 | 18557 | 26766 | 26446 | 1736 |
| 77 | 19091 | 28993 | 27755 | 1763 |
| 78 | 19642 | 31480 | 29189 | 1790 |
| 79 | 20210 | 34272 | 30769 | 1816 |
| 80 | 20794 | 37426 | 32522 | 1842 |

$\lambda = 0{\cdot}26$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 55° | 38874 | 39352 | 21813 | 7608 |
| 54¾ | 36612 | 36137 | 21268 | 6825 |
| 54½ | 34756 | 33522 | 20776 | 6241 |
| 54¼ | 33183 | 31326 | 20326 | 5783 |
| 54 | 31819 | 29439 | 19910 | 5410 |
| 53¾ | 30615 | 27791 | 19522 | 5100 |

$\lambda = 0{\cdot}26$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 53½° | 29540 | 26330 | 19156 | 4836 |
| 53¼ | 28567 | 25022 | 18811 | 4609 |
| 53 | 27681 | 23841 | 18483 | 4409 |
| 52¾ | 26867 | 22765 | 18171 | 4233 |
| 52½ | 26115 | 21780 | 17873 | 4075 |
| 52¼ | 25415 | 20873 | 17586 | 3933 |
| 52 | 24762 | 20033 | 17312 | 3805 |
| 51¾ | 24150 | 19253 | 17047 | 3687 |
| 51½ | 23575 | 18526 | 16792 | 3580 |
| 51¼ | 23031 | 17846 | 16545 | 3480 |
| 51 | 22517 | 17208 | 16306 | 3388 |
| 50 | 20698 | 14999 | 15421 | 3080 |
| 49 | 19173 | 13213 | 14626 | 2839 |
| 48 | 17864 | 11733 | 13905 | 2644 |
| 47 | 16719 | 10483 | 13244 | 2482 |
| 46 | 15703 | 9412 | 12632 | 2345 |
| 45 | 14792 | 8484 | 12063 | 2227 |
| 44 | 13966 | 7673 | 11531 | 2125 |
| 43 | 13212 | 6957 | 11031 | 2034 |
| 42 | 12519 | 6322 | 10559 | 1953 |
| 41 | 11878 | 5754 | 10112 | 1881 |
| 40 | 11282 | 5245 | 9688 | 1816 |

$\lambda = 0{\cdot}28$

| $\phi$ | $(x)$ | $(y)$ | $(t$ | $(v)$ |
|---|---|---|---|---|
| 53½° | 36958 | 35386 | 20700 | 7288 |
| 53¼ | 34872 | 32580 | 20194 | 6570 |
| 53 | 33147 | 30279 | 19737 | 6026 |
| 52¾ | 31677 | 28336 | 19318 | 5597 |
| 52½ | 30397 | 26660 | 18928 | 5246 |
| 52¼ | 29264 | 25190 | 18564 | 4952 |
| 52 | 28248 | 23885 | 18221 | 4701 |
| 51¾ | 27329 | 22713 | 17897 | 4484 |
| 51½ | 26489 | 21652 | 17589 | 4294 |
| 51¼ | 25716 | 20685 | 17294 | 4125 |
| 51 | 25001 | 19798 | 17013 | 3974 |
| 50¾ | 24336 | 18980 | 16743 | 3838 |

IX. (*continued*).

| $\lambda = 0{\cdot}28$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $50\frac{1}{2}°$ | 23714 | 18222 | 16483 | 3714 |
| $50\frac{1}{4}$ | 23130 | 17518 | 16233 | 3601 |
| 50 | 22581 | 16860 | 15992 | 3497 |
| 49 | 20659 | 14608 | 15100 | 3154 |
| 48 | 19069 | 12810 | 14305 | 2891 |
| 47 | 17716 | 11333 | 13586 | 2682 |
| 46 | 16542 | 10095 | 12928 | 2510 |
| 45 | 15506 | 9040 | 12322 | 2366 |
| 44 | 14580 | 8129 | 11758 | 2243 |
| 43 | 13744 | 7336 | 11232 | 2136 |
| 42 | 12983 | 6638 | 10737 | 2042 |
| 41 | 12284 | 6021 | 10271 | 1960 |
| 40 | 11640 | 5470 | 9830 | 1885 |

| $\lambda = 0{\cdot}30$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 52° | 34743 | 31376 | 19582 | 6836 |
| $51\frac{3}{4}$ | 32892 | 29018 | 19122 | 6213 |
| $51\frac{1}{2}$ | 31340 | 27057 | 18702 | 5732 |
| $51\frac{1}{4}$ | 30003 | 25384 | 18316 | 5347 |
| 51 | 28831 | 23930 | 17955 | 5028 |
| $50\frac{3}{4}$ | 27787 | 22647 | 17617 | 4759 |
| $50\frac{1}{2}$ | 26847 | 21501 | 17298 | 4528 |
| $50\frac{1}{4}$ | 25993 | 20469 | 16995 | 4327 |
| 50 | 25210 | 19532 | 16707 | 4149 |
| $49\frac{3}{4}$ | 24487 | 18675 | 16431 | 3993 |
| $49\frac{1}{2}$ | 23817 | 17886 | 16167 | 3850 |
| $49\frac{1}{4}$ | 23192 | 17158 | 15914 | 3721 |
| 49 | 22607 | 16482 | 15670 | 3605 |
| 48 | 20582 | 14191 | 14773 | 3224 |
| 47 | 18930 | 12386 | 13978 | 2940 |
| 46 | 17537 | 10918 | 13262 | 2716 |
| 45 | 16337 | 9696 | 12609 | 2535 |
| 44 | 15283 | 8660 | 12008 | 2384 |
| 43 | 14345 | 7770 | 11450 | 2255 |
| 42 | 13501 | 6996 | 10929 | 2144 |
| 41 | 12735 | 6318 | 10441 | 2048 |
| 40 | 12034 | 5719 | 9981 | 1962 |

| $\lambda = 0{\cdot}30$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 39° | 11388 | 5187 | 9546 | 1886 |
| 38 | 10789 | 4710 | 9133 | 1818 |
| 37 | 10232 | 4283 | 8740 | 1757 |
| 36 | 9711 | 3897 | 8365 | 1701 |
| 35 | 9221 | 3547 | 8005 | 1650 |
| 34 | 8760 | 3231 | 7661 | 1603 |
| 33 | 8324 | 2942 | 7330 | 1560 |
| 32 | 7910 | 2678 | 7012 | 1520 |
| 31 | 7516 | 2437 | 6704 | 1483 |
| 30 | 7141 | 2216 | 6407 | 1449 |
| 29 | 6783 | 2013 | 6120 | 1417 |
| 28 | 6440 | 1827 | 5842 | 1387 |
| 27 | 6111 | 1656 | 5571 | 1359 |
| 26 | 5795 | 1498 | 5309 | 1333 |
| 25 | 5490 | 1352 | 5053 | 1309 |
| 24 | 5196 | 1219 | 4805 | 1286 |
| 23 | 4912 | 1095 | 4562 | 1265 |
| 22 | 4638 | 981·3 | 4325 | 1244 |
| 21 | 4371 | 876·4 | 4093 | 1225 |
| 20 | 4113 | 779·9 | 3866 | 1207 |
| 19 | 3862 | 691·0 | 3644 | 1190 |
| 18 | 3618 | 609·4 | 3427 | 1174 |
| 17 | 3381 | 534·5 | 3213 | 1159 |
| 16 | 3149 | 465·9 | 3003 | 1145 |
| 15 | 2923 | 403·2 | 2797 | 1131 |
| 14 | 2702 | 346·0 | 2595 | 1119 |
| 13 | 2486 | 294·2 | 2395 | 1107 |
| 12 | 2275 | 247·3 | 2198 | 1095 |
| 11 | 2068 | 205·1 | 2004 | 1084 |
| 10 | 1864 | 167·4 | 1813 | 1074 |
| 9 | 1665 | 134·0 | 1623 | 1065 |
| 8 | 1469 | 94·7 | 1436 | 1055 |
| 7 | 1276 | 79·3 | 1251 | 1047 |
| 6 | 1086 | 57·7 | 1068 | 1039 |
| 5 | 899 | 39·7 | 887 | 1031 |
| 4 | 714 | 25·2 | 707 | 1024 |
| 3 | 533 | 14·0 | 528 | 1017 |
| 2 | 353 | 6·2 | 351 | 1011 |
| +1 | 176 | 1·5 | 175 | 1006 |
| 0 | 0 | 0 | 0 | 1000 |

IX. (*continued*).

| $\lambda = 0{\cdot}30$ | | | | | $\lambda = 0{\cdot}30$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| −1° | 174 | 1·5 | 174 | 995 | 40° | 6737 | 2620 | 7504 | 1046 |
| 2 | 346 | 6·0 | 347 | 990 | 41 | 6930 | 2784 | 7745 | 1054 |
| 3 | 516 | 13·5 | 520 | 986 | 42 | 7125 | 2957 | 7991 | 1062 |
| 4 | 685 | 23·8 | 692 | 982 | 43 | 7323 | 3139 | 8244 | 1070 |
| 5 | 853 | 37·0 | 864 | 978 | 44 | 7525 | 3330 | 8502 | 1079 |
| 6 | 1019 | 53·0 | 1035 | 975 | 45 | 7730 | 3531 | 8768 | 1088 |
| 7 | 1185 | 71·9 | 1206 | 972 | 46 | 7938 | 3744 | 9040 | 1098 |
| 8 | 1349 | 93·5 | 1377 | 970 | 47 | 8151 | 3967 | 9319 | 1108 |
| 9 | 1513 | 118·0 | 1548 | 967 | 48 | 8367 | 4203 | 9607 | 1119 |
| 10 | 1676 | 145·3 | 1719 | 965 | 49 | 8588 | 4453 | 9903 | 1129 |
| 11 | 1839 | 175·4 | 1890 | 964 | 50 | 8813 | 4716 | 10208 | 1141 |
| 12 | 2000 | 208·3 | 2061 | 962 | 51 | 9042 | 4995 | 10523 | 1153 |
| 13 | 2162 | 244·1 | 2233 | 961 | 52 | 9276 | 5289 | 10848 | 1165 |
| 14 | 2323 | 282·8 | 2406 | 961 | 53 | 9516 | 5601 | 11184 | 1178 |
| 15 | 2484 | 324·4 | 2579 | 960 | 54 | 9761 | 5932 | 11531 | 1191 |
| 16 | 2645 | 369·0 | 2753 | 960 | 55 | 10011 | 6284 | 11892 | 1205 |
| 17 | 2805 | 416·7 | 2928 | 960 | 56 | 10268 | 6657 | 12265 | 1219 |
| 18 | 2966 | 467·4 | 3103 | 961 | 57 | 10530 | 7054 | 12653 | 1234 |
| 19 | 3127 | 521·3 | 3280 | 961 | 58 | 10800 | 7477 | 13057 | 1250 |
| 20 | 3289 | 578·5 | 3458 | 962 | 59 | 11076 | 7927 | 13477 | 1265 |
| 21 | 3451 | 639·0 | 3638 | 963 | 60 | 11359 | 8408 | 13915 | 1282 |
| 22 | 3613 | 702·9 | 3819 | 965 | 61 | 11649 | 8921 | 14372 | 1299 |
| 23 | 3776 | 770·4 | 4001 | 967 | 62 | 11948 | 9471 | 14850 | 1316 |
| 24 | 3940 | 841·5 | 4186 | 969 | 63 | 12254 | 10060 | 15351 | 1334 |
| 25 | 4104 | 916·4 | 4372 | 972 | 64 | 12569 | 10692 | 15877 | 1353 |
| 26 | 4269 | 995·2 | 4560 | 974 | 65 | 12893 | 11372 | 16429 | 1372 |
| 27 | 4435 | 1078 | 4750 | 977 | 66 | 13227 | 12103 | 17011 | 1392 |
| 28 | 4603 | 1165 | 4943 | 981 | 67 | 13569 | 12892 | 17625 | 1412 |
| 29 | 4771 | 1257 | 5138 | 984 | 68 | 13923 | 13744 | 18274 | 1432 |
| 30 | 4941 | 1353 | 5336 | 988 | 69 | 14286 | 14667 | 18961 | 1453 |
| 31 | 5112 | 1454 | 5537 | 993 | 70 | 14660 | 15668 | 19691 | 1475 |
| 32 | 5285 | 1560 | 5740 | 997 | 71 | 15045 | 16756 | 20468 | 1497 |
| 33 | 5459 | 1671 | 5947 | 1002 | 72 | 15442 | 17942 | 21297 | 1519 |
| 34 | 5636 | 1787 | 6158 | 1007 | 73 | 15850 | 19238 | 22185 | 1541 |
| 35 | 5814 | 1910 | 6371 | 1013 | 74 | 16271 | 20658 | 23139 | 1563 |
| 36 | 5994 | 2038 | 6589 | 1019 | 75 | 16704 | 22220 | 24168 | 1586 |
| 37 | 6176 | 2173 | 6811 | 1025 | 76 | 17149 | 23943 | 25282 | 1609 |
| 38 | 6361 | 2315 | 7037 | 1032 | 77 | 17607 | 25852 | 26494 | 1631 |
| 39 | 6548 | 2464 | 7268 | 1039 | 78 | 18078 | 27976 | 27819 | 1653 |
| | | | | | 79 | 18561 | 30354 | 29277 | 1675 |
| | | | | | 80 | 19057 | 33032 | 30893 | 1696 |

IX. (*continued*).

| $\lambda = 0{\cdot}32$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $50\frac{1}{2}°$ | 32378 | 27524 | 18478 | 6317 |
| $50\frac{1}{4}$ | 30781 | 25595 | 18064 | 5800 |
| 50 | 29418 | 23963 | 17683 | 5391 |
| $49\frac{3}{4}$ | 28229 | 22552 | 17330 | 5055 |
| $49\frac{1}{2}$ | 27176 | 21314 | 16999 | 4775 |
| $49\frac{1}{4}$ | 26232 | 20213 | 16688 | 4535 |
| 49 | 25376 | 19224 | 16392 | 4327 |
| $48\frac{3}{4}$ | 24594 | 18328 | 16111 | 4145 |
| $48\frac{1}{2}$ | 23873 | 17510 | 15843 | 3983 |
| $48\frac{1}{4}$ | 23206 | 16760 | 15586 | 3838 |
| 48 | 22586 | 16067 | 15340 | 3708 |
| $47\frac{3}{4}$ | 22005 | 15425 | 15103 | 3589 |
| $47\frac{1}{2}$ | 21460 | 14828 | 14874 | 3481 |
| $47\frac{1}{4}$ | 20947 | 14270 | 14653 | 3381 |
| 47 | 20461 | 13747 | 14439 | 3289 |
| 46 | 18752 | 11944 | 13646 | 2983 |
| 45 | 17324 | 10491 | 12933 | 2745 |
| 44 | 16101 | 9289 | 12286 | 2554 |
| 43 | 15033 | 8275 | 11691 | 2397 |
| 42 | 14087 | 7407 | 11139 | 2264 |
| 41 | 13238 | 6656 | 10625 | 2150 |
| 40 | 12469 | 5999 | 10144 | 2050 |
| 39 | 11766 | 5420 | 9690 | 1963 |
| 38 | 11120 | 4906 | 9261 | 1886 |
| 37 | 10523 | 4447 | 8854 | 1816 |
| 36 | 9967 | 4036 | 8466 | 1754 |
| 35 | 9448 | 3665 | 8096 | 1697 |
| 34 | 8961 | 3330 | 7743 | 1645 |
| 33 | 8502 | 3027 | 7403 | 1598 |
| 32 | 8068 | 2750 | 7077 | 1555 |
| 31 | 7657 | 2499 | 6763 | 1514 |
| 30 | 7267 | 2269 | 6460 | 1477 |

| $\lambda = 0{\cdot}34$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $49\frac{1}{4}°$ | 31586 | 25808 | 17806 | 6321 |
| 49 | 29992 | 23965 | 17404 | 5789 |
| $48\frac{3}{4}$ | 28636 | 22412 | 17034 | 5370 |

| $\lambda = 0{\cdot}34$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $48\frac{1}{2}°$ | 27459 | 21075 | 16691 | 5030 |
| $48\frac{1}{4}$ | 26418 | 19904 | 16370 | 4745 |
| 48 | 25486 | 18864 | 16068 | 4503 |
| $47\frac{3}{4}$ | 24642 | 17931 | 15782 | 4294 |
| $47\frac{1}{2}$ | 23872 | 17087 | 15510 | 4111 |
| $47\frac{1}{4}$ | 23164 | 16318 | 15251 | 3948 |
| 47 | 22509 | 15612 | 15002 | 3803 |
| $46\frac{3}{4}$ | 21900 | 14962 | 14764 | 3673 |
| $46\frac{1}{2}$ | 21330 | 14359 | 14534 | 3554 |
| $46\frac{1}{4}$ | 20796 | 13798 | 14313 | 3446 |
| 46 | 20293 | 13275 | 14099 | 3347 |
| 45 | 18533 | 11482 | 13308 | 3019 |
| 44 | 17076 | 10050 | 12601 | 2768 |
| 43 | 15836 | 8873 | 11960 | 2569 |
| 42 | 14758 | 7884 | 11372 | 2406 |
| 41 | 13806 | 7042 | 10828 | 2268 |
| 40 | 12954 | 6315 | 10321 | 2151 |
| 39 | 12185 | 5680 | 9846 | 2050 |
| 38 | 11484 | 5122 | 9399 | 1961 |
| 37 | 10840 | 4628 | 8976 | 1882 |
| 36 | 10244 | 4187 | 8575 | 1812 |
| 35 | 9692 | 3793 | 8194 | 1749 |
| 34 | 9175 | 3438 | 7829 | 1691 |
| 33 | 8692 | 3118 | 7481 | 1639 |
| 32 | 8236 | 2827 | 7147 | 1592 |
| 31 | 7806 | 2564 | 6825 | 1548 |
| 30 | 7399 | 2324 | 6516 | 1508 |

| $\lambda = 0{\cdot}35$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| – | ..... | ..... | ..... | ..... |
| 40° | 6539 | 2516 | 7389 | 1016 |
| 41 | 6720 | 2671 | 7623 | 1023 |
| 42 | 6904 | 2834 | 7862 | 1030 |
| 43 | 7091 | 3005 | 8107 | 1037 |
| 44 | 7280 | 3184 | 8357 | 1045 |
| 45 | 7472 | 3373 | 8614 | 1053 |

## IX. (*continued*).

| $\lambda = 0{\cdot}35$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 46° | 7667 | 3572 | 8877 | 1062 |
| 47 | 7865 | 3781 | 9148 | 1070 |
| 48 | 8067 | 4001 | 9425 | 1080 |
| 49 | 8272 | 4233 | 9711 | 1089 |
| 50 | 8481 | 4478 | 10005 | 1099 |
| 51 | 8694 | 4736 | 10308 | 1110 |
| 52 | 8911 | 5009 | 10621 | 1121 |
| 53 | 9133 | 5297 | 10944 | 1132 |
| 54 | 9359 | 5603 | 11278 | 1144 |
| 55 | 9589 | 5926 | 11623 | 1156 |
| 56 | 9825 | 6269 | 11981 | 1168 |
| 57 | 10066 | 6633 | 12353 | 1181 |
| 58 | 10312 | 7020 | 12739 | 1195 |
| 59 | 10564 | 7432 | 13140 | 1209 |
| 60 | 10822 | 7870 | 13559 | 1223 |
| 61 | 11087 | 8337 | 13995 | 1238 |
| 62 | 11358 | 8836 | 14451 | 1253 |
| 63 | 11635 | 9369 | 14927 | 1269 |
| 64 | 11920 | 9940 | 15427 | 1285 |
| 65 | 12212 | 10553 | 15951 | 1302 |
| 66 | 12512 | 11211 | 16503 | 1319 |
| 67 | 12819 | 11918 | 17084 | 1336 |
| 68 | 13135 | 12681 | 17698 | 1354 |
| 69 | 13459 | 13505 | 18347 | 1372 |
| 70 | 13793 | 14396 | 19036 | 1391 |
| 71 | 14135 | 15363 | 19768 | 1410 |
| 72 | 14486 | 16414 | 20549 | 1429 |
| 73 | 14847 | 17559 | 21384 | 1448 |
| 74 | 15218 | 18811 | 22280 | 1467 |
| 75 | 15599 | 20185 | 23245 | 1486 |
| 76 | 15989 | 21696 | 24289 | 1506 |
| 77 | 16390 | 23366 | 25422 | 1525 |
| 78 | 16801 | 25221 | 26660 | 1544 |
| 79 | 17222 | 27291 | 28020 | 1562 |
| 80 | 17653 | 29618 | 29525 | 1580 |

| $\lambda = 0{\cdot}36$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 48° | 30527 | 23909 | 17111 | 6217 |
| 47¾ | 28984 | 22203 | 16724 | 5695 |
| 47½ | 27672 | 20764 | 16369 | 5285 |
| 47¼ | 26532 | 19525 | 16040 | 4950 |
| 47 | 25523 | 18439 | 15731 | 4671 |
| 46¾ | 24620 | 17475 | 15441 | 4433 |
| 46½ | 23803 | 16609 | 15166 | 4228 |
| 46¼ | 23056 | 15826 | 14905 | 4048 |
| 46 | 22370 | 15112 | 14655 | 3888 |
| 45¾ | 21735 | 14457 | 14416 | 3746 |
| 45½ | 21144 | 13853 | 14186 | 3617 |
| 45¼ | 20591 | 13293 | 13965 | 3501 |
| 45 | 20073 | 12773 | 13752 | 3394 |
| 44 | 18271 | 11001 | 12966 | 3047 |
| 43 | 16792 | 9597 | 12266 | 2784 |
| 42 | 15541 | 8449 | 11632 | 2578 |
| 41 | 14457 | 7490 | 11051 | 2409 |
| 40 | 13504 | 6676 | 10515 | 2269 |
| 39 | 12653 | 5974 | 10015 | 2149 |
| 38 | 11885 | 5363 | 9548 | 2046 |
| 37 | 11187 | 4827 | 9108 | 1956 |
| 36 | 10547 | 4353 | 8692 | 1876 |
| 35 | 9956 | 3931 | 8297 | 1805 |
| 34 | 9407 | 3554 | 7922 | 1742 |
| 33 | 8895 | 3215 | 7563 | 1684 |
| 32 | 8416 | 2910 | 7220 | 1632 |
| 31 | 7965 | 2634 | 6891 | 1584 |
| 30 | 7539 | 2383 | 6575 | 1540 |

| $\lambda = 0{\cdot}38$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 47° | 30981 | 23758 | 16798 | 6660 |
| 46¾ | 29236 | 21894 | 16395 | 6016 |
| 46½ | 27787 | 20360 | 16029 | 5527 |
| 46¼ | 26549 | 19060 | 15692 | 5139 |
| 46 | 25468 | 17937 | 15379 | 4821 |
| 45¾ | 24510 | 16949 | 15085 | 4555 |

## IX. (*continued*).

| $\lambda = 0{\cdot}38$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $45\frac{1}{2}°$ | 23651 | 16070 | 14808 | 4328 |
| $45\frac{1}{4}$ | 22871 | 15280 | 14546 | 4131 |
| 45 | 22157 | 14563 | 14296 | 3958 |
| $44\frac{3}{4}$ | 21501 | 13909 | 14057 | 3804 |
| $44\frac{1}{2}$ | 20892 | 13309 | 13828 | 3667 |
| $44\frac{1}{4}$ | 20325 | 12754 | 13608 | 3543 |
| 44 | 19795 | 12240 | 13396 | 3430 |
| 43 | 17963 | 10501 | 12617 | 3065 |
| 42 | 16471 | 9132 | 11925 | 2793 |
| 41 | 15214 | 8020 | 11300 | 2580 |
| 40 | 14130 | 7094 | 10728 | 2408 |
| 39 | 13179 | 6309 | 10200 | 2265 |
| 38 | 12332 | 5635 | 9708 | 2144 |
| 37 | 11569 | 5049 | 9248 | 2039 |
| 36 | 10876 | 4536 | 8816 | 1948 |
| 35 | 10241 | 4083 | 8407 | 1868 |
| 34 | 9655 | 3681 | 8019 | 1797 |
| 33 | 9112 | 3321 | 7650 | 1732 |
| 32 | 8606 | 2998 | 7297 | 1675 |
| 31 | 8132 | 2708 | 6960 | 1622 |
| 30 | 7686 | 2445 | 6636 | 1574 |

| $\lambda = 0{\cdot}40$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $46°$ | 31301 | 23464 | 16461 | 7091 |
| $45\frac{3}{4}$ | 29352 | 21454 | 16042 | 6312 |
| $45\frac{1}{2}$ | 27773 | 19840 | 15667 | 5741 |
| $45\frac{1}{4}$ | 26446 | 18496 | 15325 | 5300 |
| 45 | 25304 | 17348 | 15008 | 4945 |
| $44\frac{3}{4}$ | 24300 | 16349 | 14713 | 4653 |
| $44\frac{1}{2}$ | 23406 | 15466 | 14436 | 4406 |
| $44\frac{1}{4}$ | 22600 | 14678 | 14173 | 4194 |
| 44 | 21867 | 13966 | 13924 | 4009 |
| $43\frac{3}{4}$ | 21194 | 13320 | 13686 | 3846 |
| $43\frac{1}{2}$ | 20573 | 12728 | 13459 | 3701 |
| $43\frac{1}{4}$ | 19997 | 12183 | 13241 | 3570 |
| 43 | 19459 | 11679 | 13031 | 3453 |

| $\lambda = 0{\cdot}40$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $42\frac{3}{4}°$ | 18955 | 11211 | 12829 | 3345 |
| $42\frac{1}{2}$ | 18481 | 10775 | 12633 | 3247 |
| $42\frac{1}{4}$ | 18034 | 10367 | 12444 | 3157 |
| 42 | 17611 | 9984 | 12261 | 3074 |
| 41 | 16114 | 8659 | 11578 | 2794 |
| 40 | 14859 | 7586 | 10963 | 2577 |
| 39 | 13780 | 6696 | 10401 | 2402 |
| 38 | 12834 | 5944 | 9882 | 2257 |
| 37 | 11994 | 5299 | 9399 | 2134 |
| 36 | 11238 | 4740 | 8947 | 2029 |
| 35 | 10552 | 4250 | 8522 | 1938 |
| 34 | 9924 | 3819 | 8120 | 1857 |
| 33 | 9346 | 3435 | 7739 | 1785 |
| 32 | 8810 | 3094 | 7377 | 1721 |
| 31 | 8310 | 2787 | 7030 | 1664 |
| 30 | 7842 | 2512 | 6699 | 1611 |
| 29 | 7403 | 2263 | 6380 | 1564 |
| 28 | 6988 | 2038 | 6074 | 1520 |
| 27 | 6596 | 1834 | 5779 | 1480 |
| 26 | 6223 | 1648 | 5494 | 1443 |
| 25 | 5869 | 1479 | 5219 | 1408 |
| 24 | 5530 | 1324 | 4952 | 1377 |
| 23 | 5207 | 1184 | 4693 | 1347 |
| 22 | 4897 | 1055 | 4441 | 1319 |
| 21 | 4599 | 937·8 | 4196 | 1294 |
| 20 | 4312 | 830·6 | 3957 | 1270 |
| 19 | 4036 | 732·8 | 3724 | 1247 |
| 18 | 3769 | 643·5 | 3496 | 1226 |
| 17 | 3511 | 562·1 | 3274 | 1206 |
| 16 | 3261 | 488·0 | 3056 | 1188 |
| 15 | 3019 | 420·8 | 2842 | 1170 |
| 14 | 2783 | 359·9 | 2633 | 1153 |
| 13 | 2554 | 304·9 | 2427 | 1138 |
| 12 | 2331 | 255·5 | 2225 | 1123 |
| 11 | 2114 | 211·2 | 2026 | 1109 |
| 10 | 1901 | 171·9 | 1831 | 1096 |
| 9 | 1694 | 137·2 | 1638 | 1084 |
| 8 | 1491 | 106·9 | 1447 | 1072 |
| 7 | 1293 | 80·7 | 1260 | 1061 |

## IX. (*continued*).

| $\lambda = 0{\cdot}40$ | | | | | $\lambda = 0{\cdot}40$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 6° | 1098 | 58·5 | 1074 | 1051 | 34° | 5362 | 1672 | 6002 | 960 |
| 5 | 907 | 40·2 | 891 | 1041 | 35 | 5524 | 1783 | 6206 | 964 |
| 4 | 720 | 25·4 | 709 | 1033 | 36 | 5687 | 1899 | 6413 | 968 |
| 3 | 536 | 14·1 | 530 | 1023 | 37 | 5851 | 2021 | 6623 | 973 |
| 2 | 354 | 6·2 | 352 | 1015 | 38 | 6017 | 2148 | 6838 | 978 |
| 1 | 176 | 1·5 | 175 | 1007 | 39 | 6185 | 2282 | 7057 | 983 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 173 | 1·5 | 174 | 993 | 40 | 6355 | 2422 | 7280 | 989 |
| 2 | 344 | 6·0 | 347 | 987 | 41 | 6526 | 2568 | 7508 | 995 |
| 3 | 513 | 13·4 | 519 | 981 | 42 | 6700 | 2722 | 7740 | 1001 |
| 4 | 681 | 23·6 | 690 | 975 | 43 | 6876 | 2883 | 7978 | 1007 |
| 5 | 846 | 36·6 | 861 | 970 | 44 | 7054 | 3052 | 8221 | 1014 |
| 6 | 1009 | 52·3 | 1030 | 966 | 45 | 7235 | 3230 | 8470 | 1021 |
| 7 | 1171 | 70·8 | 1200 | 961 | 46 | 7418 | 3416 | 8725 | 1029 |
| 8 | 1332 | 91·9 | 1368 | 958 | 47 | 7604 | 3613 | 8987 | 1036 |
| 9 | 1491 | 115·7 | 1537 | 954 | 48 | 7793 | 3819 | 9256 | 1045 |
| 10 | 1649 | 142·2 | 1705 | 950 | 49 | 7985 | 4036 | 9532 | 1053 |
| 11 | 1806 | 171·3 | 1874 | 947 | 50 | 8180 | 4264 | 9816 | 1062 |
| 12 | 1963 | 203·1 | 2042 | 945 | 51 | 8378 | 4505 | 10109 | 1071 |
| 13 | 2118 | 237·5 | 2211 | 942 | 52 | 8581 | 4759 | 10411 | 1081 |
| 14 | 2273 | 274·6 | 2380 | 940 | 53 | 8786 | 5028 | 10722 | 1091 |
| 15 | 2427 | 314·5 | 2549 | 938 | 54 | 8996 | 5311 | 11044 | 1101 |
| 16 | 2580 | 357·0 | 2719 | 937 | 55 | 9210 | 5611 | 11376 | 1112 |
| 17 | 2733 | 402·4 | 2890 | 936 | 56 | 9428 | 5928 | 11721 | 1123 |
| 18 | 2886 | 450·5 | 3061 | 935 | 57 | 9650 | 6264 | 12078 | 1135 |
| 19 | 3038 | 501·5 | 3233 | 935 | 58 | 9877 | 6621 | 12448 | 1147 |
| 20 | 3191 | 555·5 | 3406 | 934 | 59 | 10109 | 7000 | 12834 | 1159 |
| 21 | 3343 | 612·5 | 3580 | 934 | 60 | 10347 | 7402 | 13235 | 1172 |
| 22 | 3495 | 672·5 | 3755 | 935 | 61 | 10589 | 7831 | 13652 | 1185 |
| 23 | 3648 | 735·7 | 3932 | 935 | 62 | 10837 | 8287 | 14088 | 1199 |
| 24 | 3800 | 802·1 | 4110 | 936 | 63 | 11091 | 8775 | 14544 | 1213 |
| 25 | 3954 | 871·9 | 4289 | 937 | 64 | 11350 | 9296 | 15021 | 1227 |
| 26 | 4107 | 945·1 | 4471 | 939 | 65 | 11616 | 9853 | 15522 | 1242 |
| 27 | 4261 | 1022 | 4654 | 940 | 66 | 11888 | 10451 | 16047 | 1256 |
| 28 | 4416 | 1102 | 4839 | 942 | 67 | 12167 | 11092 | 16601 | 1272 |
| 29 | 4571 | 1187 | 5027 | 945 | 68 | 12453 | 11783 | 17185 | 1288 |
| 30 | 4728 | 1275 | 5216 | 947 | 69 | 12746 | 12527 | 17802 | 1304 |
| 31 | 4885 | 1368 | 5409 | 950 | 70 | 13046 | 13330 | 18456 | 1320 |
| 32 | 5043 | 1464 | 5603 | 953 | 71 | 13354 | 14200 | 19150 | 1336 |
| 33 | 5202 | 1566 | 5801 | 957 | 72 | 13670 | 15143 | 19890 | 1353 |

IX. (*continued*).

$\lambda = 0{\cdot}40$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 73° | 13993 | 16169 | 20681 | 1372 |
| 74 | 14325 | 17289 | 21528 | 1387 |
| 75 | 14665 | 18514 | 22439 | 1403 |
| 76 | 15012 | 19861 | 23424 | 1420 |
| 77 | 15369 | 21345 | 24493 | 1437 |
| 78 | 15733 | 22991 | 25659 | 1453 |
| 79 | 16106 | 24824 | 26939 | 1469 |
| 80 | 16487 | 26881 | 28355 | 1485 |

$\lambda = 0{\cdot}42$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 44½° | 27597 | 19185 | 15282 | 5908 |
| 44¼ | 26202 | 17820 | 14937 | 5419 |
| 44 | 25012 | 16666 | 14620 | 5034 |
| 43¾ | 23977 | 15670 | 14325 | 4719 |
| 43½ | 23059 | 14796 | 14048 | 4456 |
| 43¼ | 22237 | 14019 | 13788 | 4232 |
| 43 | 21492 | 13320 | 13541 | 4037 |
| 42¾ | 20811 | 12688 | 13305 | 3867 |
| 42½ | 20184 | 12111 | 13081 | 3716 |
| 42¼ | 19603 | 11581 | 12865 | 3581 |
| 42 | 19062 | 11092 | 12658 | 3460 |
| 41 | 17212 | 9454 | 11900 | 3071 |
| 40 | 15721 | 8179 | 11229 | 2786 |
| 39 | 14474 | 7151 | 10625 | 2566 |
| 38 | 13405 | 6300 | 10073 | 2390 |
| 37 | 12469 | 5582 | 9563 | 2244 |
| 36 | 11639 | 4967 | 9090 | 2121 |
| 35 | 10893 | 4435 | 8646 | 2016 |
| 34 | 10217 | 3970 | 8229 | 1924 |
| 33 | 9598 | 3560 | 7835 | 1844 |
| 32 | 9028 | 3197 | 7461 | 1772 |
| 31 | 8499 | 2873 | 7105 | 1708 |
| 30 | 8007 | 2583 | 6765 | 1651 |

$\lambda = 0{\cdot}44$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 43½° | 27235 | 18385 | 14871 | 6008 |
| 43¼ | 25799 | 17027 | 14526 | 5485 |
| 43 | 24585 | 15890 | 14211 | 5077 |
| 42¾ | 23534 | 14914 | 13919 | 4747 |
| 42½ | 22608 | 14062 | 13646 | 4474 |
| 42¼ | 21780 | 13307 | 13389 | 4241 |
| 42 | 21033 | 12631 | 13145 | 4041 |
| 41¾ | 20351 | 12020 | 12913 | 3867 |
| 41½ | 19725 | 11463 | 12692 | 3712 |
| 41¼ | 19146 | 10953 | 12481 | 3575 |
| 41 | 18608 | 10483 | 12277 | 3451 |
| 40¾ | 18105 | 10048 | 12081 | 3339 |
| 40½ | 17633 | 9644 | 11892 | 3237 |
| 40¼ | 17190 | 9267 | 11710 | 3143 |
| 40 | 16771 | 8913 | 11533 | 3057 |
| 39 | 15295 | 7696 | 10875 | 2770 |
| 38 | 14064 | 6716 | 10283 | 2549 |
| 37 | 13009 | 5906 | 9742 | 2372 |
| 36 | 12088 | 5224 | 9243 | 2227 |
| 35 | 11270 | 4641 | 8779 | 2104 |
| 34 | 10536 | 4137 | 8345 | 1999 |
| 33 | 9871 | 3696 | 7937 | 1908 |
| 32 | 9263 | 3308 | 7550 | 1828 |
| 31 | 8702 | 2965 | 7183 | 1757 |
| 30 | 8183 | 2659 | 6834 | 1693 |

$\lambda = 0{\cdot}45$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| – | ..... | ..... | ..... | ..... |
| 40° | 6184 | 2335 | 7177 | 963 |
| 41 | 6347 | 2474 | 7399 | 968 |
| 42 | 6511 | 2620 | 7625 | 974 |
| 43 | 6678 | 2772 | 7856 | 980 |
| 44 | 6846 | 2932 | 8093 | 986 |
| 45 | 7017 | 3100 | 8335 | 992 |

IX. (*continued*).

| $\lambda = 0{\cdot}45$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 46° | 7190 | 3276 | 8582 | 998 |
| 47 | 7365 | 3460 | 8837 | 1005 |
| 48 | 7543 | 3654 | 9097 | 1013 |
| 49 | 7723 | 3858 | 9365 | 1020 |
| 50 | 7906 | 4072 | 9640 | 1028 |
| 51 | 8092 | 4298 | 9924 | 1037 |
| 52 | 8281 | 4536 | 10215 | 1045 |
| 53 | 8473 | 4786 | 10516 | 1054 |
| 54 | 8669 | 5051 | 10827 | 1063 |
| 55 | 8868 | 5330 | 11148 | 1073 |
| 56 | 9071 | 5625 | 11480 | 1083 |
| 57 | 9278 | 5937 | 11825 | 1093 |
| 58 | 9489 | 6268 | 12182 | 1104 |
| 59 | 9703 | 6619 | 12552 | 1115 |
| 60 | 9923 | 6991 | 12938 | 1127 |
| 61 | 10147 | 7387 | 13339 | 1138 |
| 62 | 10375 | 7808 | 13758 | 1150 |
| 63 | 10609 | 8257 | 14195 | 1163 |
| 64 | 10847 | 8735 | 14653 | 1176 |
| 65 | 11091 | 9247 | 15132 | 1189 |
| 66 | 11341 | 9795 | 15635 | 1202 |
| 67 | 11596 | 10382 | 16165 | 1216 |
| 68 | 11857 | 11012 | 16723 | 1230 |
| 69 | 12124 | 11690 | 17312 | 1244 |
| 70 | 12397 | 12422 | 17936 | 1259 |
| 71 | 12677 | 13212 | 18598 | 1273 |
| 72 | 12963 | 14068 | 19302 | 1288 |
| 73 | 13256 | 14997 | 20055 | 1303 |
| 74 | 13556 | 16010 | 20860 | 1318 |
| 75 | 13863 | 17116 | 21726 | 1333 |
| 76 | 14176 | 18329 | 22661 | 1348 |
| 77 | 14497 | 19666 | 23675 | 1363 |
| 78 | 14825 | 21144 | 24781 | 1377 |
| 79 | 15159 | 22790 | 25993 | 1391 |
| 80 | 15500 | 24633 | 27334 | 1405 |

| $\lambda = 0{\cdot}46$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 42½° | 26673 | 17443 | 14432 | 6027 |
| 42¼ | 25232 | 16127 | 14093 | 5488 |
| 42 | 24019 | 15031 | 13783 | 5070 |
| 41¾ | 22973 | 14092 | 13496 | 4734 |
| 41½ | 22053 | 13275 | 13228 | 4456 |
| 41¼ | 21232 | 12552 | 12976 | 4222 |
| 41 | 20492 | 11906 | 12737 | 4019 |
| 40¾ | 19818 | 11323 | 12510 | 3844 |
| 40½ | 19200 | 10792 | 12294 | 3688 |
| 40¼ | 18629 | 10306 | 12087 | 3550 |
| 40 | 18098 | 9859 | 11888 | 3426 |
| 39¾ | 17603 | 9445 | 11696 | 3314 |
| 39½ | 17139 | 9061 | 11511 | 3211 |
| 39¼ | 16702 | 8703 | 11333 | 3118 |
| 39 | 16290 | 8367 | 11160 | 3032 |
| 38 | 14839 | 7213 | 10517 | 2745 |
| 37 | 13630 | 6284 | 9938 | 2526 |
| 36 | 12595 | 5518 | 9409 | 2350 |
| 35 | 11691 | 4873 | 8922 | 2205 |
| 34 | 10890 | 4322 | 8468 | 2083 |
| 33 | 10170 | 3846 | 8043 | 1979 |
| 32 | 9518 | 3430 | 7643 | 1889 |
| 31 | 8921 | 3064 | 7264 | 1810 |
| 30 | 8372 | 2741 | 6905 | 1739 |

| $\lambda = 0{\cdot}48$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 41½° | 25913 | 16376 | 13970 | 5959 |
| 41¼ | 24504 | 15135 | 13639 | 5425 |
| 41 | 23319 | 14100 | 13337 | 5011 |
| 40¾ | 22296 | 13216 | 13058 | 4679 |
| 40½ | 21398 | 12445 | 12797 | 4403 |
| 40¼ | 20597 | 11763 | 12552 | 4171 |

IX. (*continued*).

| $\lambda = 0{\cdot}48$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 40° | 19874 | 11154 | 12320 | 3972 |
| 39¾ | 19216 | 10605 | 12099 | 3798 |
| 39½ | 18613 | 10105 | 11888 | 3644 |
| 39¼ | 18055 | 9647 | 11686 | 3508 |
| 39 | 17537 | 9226 | 11493 | 3385 |
| 38¾ | 17053 | 8836 | 11306 | 3274 |
| 38½ | 16600 | 8474 | 11126 | 3173 |
| 38¼ | 16174 | 8136 | 10952 | 3081 |
| 38 | 15771 | 7820 | 10784 | 2996 |
| 37 | 14355 | 6733 | 10157 | 2713 |
| 36 | 13174 | 5859 | 9592 | 2496 |
| 35 | 12163 | 5137 | 9077 | 2322 |
| 34 | 11280 | 4530 | 8600 | 2180 |
| 33 | 10497 | 4012 | 8157 | 2060 |
| 32 | 9794 | 3563 | 7742 | 1957 |
| 31 | 9156 | 3173 | 7350 | 1868 |
| 30 | 8573 | 2829 | 6980 | 1790 |

| $\lambda = 0{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 41° | 28738 | 18464 | 14241 | 7506 |
| 40¾ | 26617 | 16628 | 13839 | 6499 |
| 40½ | 24972 | 15217 | 13486 | 5810 |
| 40¼ | 23630 | 14076 | 13169 | 5301 |
| 40 | 22497 | 13120 | 12878 | 4904 |
| 39¾ | 21517 | 12302 | 12609 | 4584 |
| 39½ | 20654 | 11587 | 12357 | 4319 |
| 39¼ | 19883 | 10954 | 12119 | 4094 |
| 39 | 19186 | 10387 | 11895 | 3900 |
| 38¾ | 18552 | 9876 | 11681 | 3731 |
| 38½ | 17969 | 9410 | 11477 | 3582 |
| 38¼ | 17430 | 8983 | 11281 | 3449 |
| 38 | 16929 | 8590 | 11093 | 3330 |
| 37¾ | 16461 | 8226 | 10912 | 3221 |
| 37½ | 16022 | 7888 | 10737 | 3123 |
| 37¼ | 15609 | 7572 | 10568 | 3033 |
| 37 | 15219 | 7277 | 10405 | 2949 |

| $\lambda = 0{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 36¾° | 14849 | 6999 | 10246 | 2873 |
| 36½ | 14498 | 6738 | 10092 | 2801 |
| 36¼ | 14163 | 6492 | 9942 | 2735 |
| 36 | 13844 | 6259 | 9796 | 2673 |
| 35 | 12698 | 5441 | 9246 | 2460 |
| 34 | 11715 | 4765 | 8744 | 2290 |
| 33 | 10856 | 4196 | 8280 | 2150 |
| 32 | 10093 | 3710 | 7847 | 2033 |
| 31 | 9408 | 3290 | 7442 | 1932 |
| 30 | 8787 | 2924 | 7059 | 1844 |
| 29 | 8218 | 2602 | 6697 | 1767 |
| 28 | 7694 | 2318 | 6353 | 1699 |
| 27 | 7208 | 2065 | 6025 | 1638 |
| 26 | 6756 | 1839 | 5711 | 1584 |
| 25 | 6332 | 1636 | 5410 | 1534 |
| 24 | 5933 | 1455 | 5120 | 1489 |
| 23 | 5557 | 1291 | 4840 | 1448 |
| 22 | 5200 | 1144 | 4570 | 1410 |
| 21 | 4862 | 1010 | 4309 | 1375 |
| 20 | 4540 | 889·8 | 4056 | 1343 |
| 19 | 4232 | 780·9 | 3810 | 1313 |
| 18 | 3938 | 682·3 | 3571 | 1285 |
| 17 | 3656 | 593·3 | 3338 | 1259 |
| 16 | 3384 | 512·8 | 3111 | 1235 |
| 15 | 3123 | 440·3 | 2890 | 1213 |
| 14 | 2870 | 375·1 | 2673 | 1192 |
| 13 | 2627 | 316·6 | 2461 | 1172 |
| 12 | 2391 | 264·3 | 2253 | 1153 |
| 11 | 2162 | 217·8 | 2049 | 1136 |
| 10 | 1940 | 176·6 | 1849 | 1120 |
| 9 | 1725 | 140·5 | 1652 | 1104 |
| 8 | 1515 | 109·1 | 1459 | 1090 |
| 7 | 1310 | 82·2 | 1268 | 1076 |
| 6 | 1111 | 59·5 | 1080 | 1063 |
| 5 | 916 | 40·7 | 895 | 1051 |
| 4 | 725 | 25·7 | 712 | 1040 |
| 3 | 538 | 14·2 | 531 | 1029 |
| 2 | 356 | 6·2 | 352 | 1019 |
| 1 | 176 | 1·5 | 175 | 1009 |
| 0 | 0 | 0 | 0 | 1000 |

## IX. (*continued*).

| $\lambda = 0{\cdot}5$ | | | | | $\lambda = 0{\cdot}5$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 1° | 173 | 1·5 | 174 | 992 | 40° | 6024 | 2254 | 7079 | 940 |
| 2 | 343 | 6·0 | 346 | 984 | 41 | 6179 | 2386 | 7295 | 944 |
| 3 | 511 | 13·3 | 517 | 976 | 42 | 6335 | 2525 | 7516 | 949 |
| 4 | 676 | 23·4 | 688 | 969 | 43 | 6493 | 2669 | 7741 | 954 |
| 5 | 839 | 36·2 | 857 | 963 | 44 | 6653 | 2821 | 7971 | 959 |
| 6 | 1000 | 51·6 | 1025 | 956 | 45 | 6814 | 2980 | 8207 | 965 |
| 7 | 1158 | 69·7 | 1192 | 951 | 46 | 6978 | 3146 | 8448 | 971 |
| 8 | 1315 | 90·4 | 1359 | 945 | 47 | 7143 | 3321 | 8695 | 977 |
| 9 | 1470 | 113·6 | 1526 | 940 | 48 | 7311 | 3504 | 8948 | 984 |
| 10 | 1624 | 139·3 | 1692 | 936 | 49 | 7481 | 3696 | 9208 | 990 |
| 11 | 1776 | 167·5 | 1857 | 932 | 50 | 7653 | 3898 | 9475 | 998 |
| 12 | 1927 | 198·2 | 2023 | 928 | 51 | 7828 | 4110 | 9750 | 1005 |
| 13 | 2077 | 231·3 | 2189 | 924 | 52 | 8006 | 4333 | 10033 | 1013 |
| 14 | 2225 | 267·0 | 2354 | 921 | 53 | 8186 | 4569 | 10324 | 1021 |
| 15 | 2373 | 305·2 | 2520 | 918 | 54 | 8370 | 4816 | 10625 | 1029 |
| 16 | 2520 | 345·9 | 2686 | 916 | 55 | 8556 | 5078 | 10936 | 1038 |
| 17 | 2666 | 389·2 | 2853 | 913 | 56 | 8746 | 5354 | 11257 | 1047 |
| 18 | 2811 | 435·0 | 3020 | 912 | 57 | 8939 | 5645 | 11589 | 1056 |
| 19 | 2956 | 483·4 | 3187 | 910 | 58 | 9135 | 5954 | 11934 | 1066 |
| 20 | 3100 | 534·5 | 3356 | 909 | 59 | 9335 | 6280 | 12292 | 1076 |
| 21 | 3244 | 588·3 | 3525 | 907 | 60 | 9539 | 6627 | 12663 | 1086 |
| 22 | 3388 | 644·9 | 3695 | 907 | 61 | 9747 | 6994 | 13050 | 1097 |
| 23 | 3531 | 704·3 | 3866 | 906 | 62 | 9959 | 7385 | 13453 | 1108 |
| 24 | 3674 | 766·6 | 4039 | 906 | 63 | 10176 | 7800 | 13874 | 1119 |
| 25 | 3818 | 831·9 | 4213 | 906 | 64 | 10396 | 8243 | 14314 | 1131 |
| 26 | 3961 | 900·3 | 4388 | 907 | 65 | 10622 | 8716 | 14775 | 1142 |
| 27 | 4104 | 971·8 | 4565 | 907 | 66 | 10852 | 9221 | 15258 | 1155 |
| 28 | 4248 | 1047 | 4743 | 908 | 67 | 11087 | 9762 | 15767 | 1167 |
| 29 | 4392 | 1125 | 4924 | 909 | 68 | 11327 | 10342 | 16302 | 1179 |
| 30 | 4537 | 1207 | 5106 | 911 | 69 | 11573 | 10965 | 16867 | 1192 |
| 31 | 4682 | 1292 | 5291 | 912 | 70 | 11824 | 11636 | 17464 | 1205 |
| 32 | 4827 | 1381 | 5478 | 914 | 71 | 12080 | 12361 | 18098 | 1218 |
| 33 | 4974 | 1474 | 5668 | 917 | 72 | 12342 | 13144 | 18772 | 1232 |
| 34 | 5121 | 1572 | 5860 | 919 | 73 | 12610 | 13994 | 19491 | 1245 |
| 35 | 5268 | 1673 | 6055 | 922 | 74 | 12883 | 14918 | 20261 | 1259 |
| 36 | 5417 | 1779 | 6253 | 925 | 75 | 13163 | 15926 | 21088 | 1272 |
| 37 | 5567 | 1890 | 6454 | 928 | 76 | 13448 | 17030 | 21980 | 1286 |
| 38 | 5718 | 2006 | 6658 | 932 | 77 | 13740 | 18245 | 22946 | 1299 |
| 39 | 5870 | 2127 | 6867 | 936 | 78 | 14037 | 19588 | 23999 | 1312 |
| | | | | | 79 | 14340 | 21080 | 25154 | 1325 |
| | | | | | 80 | 14650 | 22750 | 26430 | 1337 |

IX. (*continued*).

| $\lambda = 0{\cdot}55$ | | | | | $\lambda = 0{\cdot}6$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $38\frac{1}{2}^\circ$ | 24976 | 14445 | 12857 | 6390 | $36\frac{3}{4}^\circ$ | 26084 | 14566 | 12462 | 7665 |
| $38\frac{1}{4}$ | 23391 | 13190 | 12522 | 5698 | $36\frac{1}{2}$ | 23919 | 12956 | 12080 | 6500 |
| 38 | 22103 | 12178 | 12220 | 5189 | $36\frac{1}{4}$ | 22295 | 11760 | 11749 | 5740 |
| $37\frac{3}{4}$ | 21018 | 11335 | 11945 | 4795 | 36 | 20996 | 10812 | 11455 | 5196 |
| $37\frac{1}{2}$ | 20082 | 10613 | 11690 | 4478 | $35\frac{3}{4}$ | 19914 | 10029 | 11187 | 4780 |
| $37\frac{1}{4}$ | 19258 | 9984 | 11451 | 4216 | $35\frac{1}{2}$ | 18986 | 9364 | 10939 | 4450 |
| 37 | 18524 | 9428 | 11227 | 3995 | $35\frac{1}{4}$ | 18175 | 8788 | 10709 | 4179 |
| $36\frac{3}{4}$ | 17861 | 8931 | 11014 | 3804 | 35 | 17455 | 8281 | 10492 | 3952 |
| $36\frac{1}{2}$ | 17257 | 8482 | 10812 | 3638 | $34\frac{3}{4}$ | 16807 | 7830 | 10287 | 3758 |
| $36\frac{1}{4}$ | 16703 | 8074 | 10619 | 3492 | $34\frac{1}{2}$ | 16219 | 7424 | 10092 | 3589 |
| 36 | 16191 | 7700 | 10434 | 3361 | $34\frac{1}{4}$ | 15680 | 7055 | 9907 | 3441 |
| $35\frac{3}{4}$ | 15715 | 7356 | 10256 | 3244 | 34 | 15183 | 6718 | 9729 | 3310 |
| $35\frac{1}{2}$ | 15271 | 7037 | 10085 | 3138 | $33\frac{3}{4}$ | 14723 | 6409 | 9558 | 3192 |
| $35\frac{1}{4}$ | 14854 | 6742 | 9919 | 3042 | $33\frac{1}{2}$ | 14293 | 6123 | 9394 | 3085 |
| 35 | 14462 | 6466 | 9759 | 2954 | $33\frac{1}{4}$ | 13891 | 5858 | 9235 | 2989 |
| 34 | 13091 | 5523 | 9166 | 2663 | 33 | 13512 | 5611 | 9082 | 2901 |
| 33 | 11957 | 4772 | 8632 | 2443 | 32 | 12193 | 4770 | 8512 | 2612 |
| 32 | 10991 | 4156 | 8145 | 2268 | 31 | 11103 | 4102 | 8001 | 2393 |
| 31 | 10149 | 3640 | 7696 | 2126 | 30 | 10176 | 3556 | 7534 | 2220 |
| 30 | 9405 | 3202 | 7278 | 2006 | 29 | 9371 | 3100 | 7104 | 2080 |
| 29 | 8739 | 2824 | 6886 | 1905 | 28 | 8659 | 2713 | 6703 | 1963 |
| 28 | 8135 | 2496 | 6517 | 1817 | 27 | 8021 | 2381 | 6326 | 1863 |
| 27 | 7583 | 2209 | 6167 | 1740 | 26 | 7444 | 2093 | 5972 | 1776 |
| 26 | 7076 | 1956 | 5834 | 1672 | 25 | 6917 | 1841 | 5636 | 1701 |
| 25 | 6606 | 1732 | 5517 | 1611 | 24 | 6431 | 1620 | 5316 | 1634 |
| 24 | 6168 | 1532 | 5213 | 1557 | 23 | 5982 | 1425 | 5011 | 1575 |
| 23 | 5759 | 1354 | 4922 | 1507 | 22 | 5564 | 1252 | 4718 | 1522 |
| 22 | 5374 | 1195 | 4641 | 1463 | 21 | 5173 | 1097 | 4437 | 1474 |
| 21 | 5011 | 1052 | 4371 | 1422 | 20 | 4805 | 959·9 | 4167 | 1430 |
| 20 | 4668 | 923·3 | 4109 | 1384 | 19 | 4458 | 837·0 | 3906 | 1390 |
| 19 | 4342 | 807·8 | 3856 | 1350 | 18 | 4130 | 727·1 | 3653 | 1354 |
| 18 | 4031 | 703·9 | 3611 | 1320 | 17 | 3818 | 628·8 | 3409 | 1320 |
| 17 | 3735 | 610·4 | 3372 | 1289 | 16 | 3521 | 540·8 | 3171 | 1289 |
| 16 | 3451 | 526·4 | 3140 | 1261 | 15 | 3238 | 462·1 | 2940 | 1260 |
| 15 | 3179 | 450·9 | 2914 | 1236 | 14 | 2966 | 391·9 | 2716 | 1234 |
| | | | | | 13 | 2706 | 329·4 | 2496 | 1209 |

IX. (*continued*).

| $\lambda = 0{\cdot}6$ | | | | | $\lambda = 0{\cdot}6$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 12° | 2456 | 273·9 | 2282 | 1186 | 28° | 4096 | 996·7 | 4654 | 877 |
| 11 | 2215 | 224·8 | 2073 | 1164 | 29 | 4230 | 1070 | 4829 | 877 |
| 10 | 1982 | 181·7 | 1868 | 1144 | 30 | 4365 | 1146 | 5005 | 878 |
| 9 | 1757 | 144·1 | 1667 | 1126 | 31 | 4499 | 1225 | 5183 | 879 |
| 8 | 1540 | 111·5 | 1470 | 1108 | 32 | 4634 | 1308 | 5363 | 880 |
| 7 | 1329 | 83·7 | 1277 | 1091 | 33 | 4769 | 1394 | 5545 | 881 |
| 6 | 1124 | 60·4 | 1086 | 1076 | 34 | 4905 | 1484 | 5729 | 883 |
| 5 | 924 | 41·2 | 899 | 1061 | 35 | 5041 | 1578 | 5916 | 885 |
| 4 | 730 | 25·9 | 714 | 1047 | 36 | 5178 | 1675 | 6106 | 887 |
| 3 | 541 | 14·3 | 532 | 1034 | 37 | 5316 | 1777 | 6299 | 889 |
| 2 | 357 | 6·3 | 353 | 1022 | 38 | 5454 | 1883 | 6494 | 892 |
| 1 | 176 | 1·5 | 175 | 1011 | 39 | 5593 | 1994 | 6694 | 894 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 173 | 1·5 | 174 | 990 | 40 | 5734 | 2109 | 6897 | 898 |
| 2 | 342 | 5·9 | 346 | 980 | 41 | 5875 | 2230 | 7103 | 901 |
| 3 | 508 | 13·2 | 516 | 971 | 42 | 6017 | 2356 | 7314 | 905 |
| 4 | 672 | 23·2 | 685 | 963 | 43 | 6160 | 2487 | 7528 | 909 |
| 5 | 832 | 35·8 | 853 | 955 | 44 | 6305 | 2625 | 7747 | 913 |
| 6 | 990 | 51·0 | 1020 | 947 | 45 | 6451 | 2768 | 7971 | 917 |
| 7 | 1146 | 68·7 | 1186 | 940 | 46 | 6599 | 2918 | 8200 | 922 |
| 8 | 1299 | 88·9 | 1351 | 934 | 47 | 6748 | 3076 | 8435 | 927 |
| 9 | 1450 | 111·5 | 1515 | 928 | 48 | 6899 | 3240 | 8675 | 932 |
| 10 | 1599 | 136·5 | 1679 | 922 | 49 | 7051 | 3413 | 8921 | 938 |
| 11 | 1747 | 163·8 | 1842 | 917 | 50 | 7206 | 3593 | 9174 | 944 |
| 12 | 1893 | 193·5 | 2005 | 912 | 51 | 7362 | 3783 | 9434 | 950 |
| 13 | 2037 | 225·5 | 2167 | 907 | 52 | 7521 | 3982 | 9701 | 956 |
| 14 | 2180 | 259·8 | 2330 | 903 | 53 | 7681 | 4192 | 9976 | 963 |
| 15 | 2322 | 296·5 | 2493 | 899 | 54 | 7844 | 4412 | 10259 | 970 |
| 16 | 2462 | 335·5 | 2655 | 896 | 55 | 8009 | 4643 | 10552 | 977 |
| 17 | 2602 | 376·8 | 2818 | 893 | 56 | 8177 | 4888 | 10854 | 984 |
| 18 | 2741 | 420·5 | 2981 | 890 | 57 | 8347 | 5145 | 11166 | 992 |
| 19 | 2878 | 466·6 | 3144 | 887 | 58 | 8520 | 5417 | 11490 | 1000 |
| 20 | 3015 | 515·1 | 3309 | 885 | 59 | 8696 | 5704 | 11825 | 1008 |
| 21 | 3152 | 566·1 | 3473 | 883 | 60 | 8875 | 6008 | 12174 | 1016 |
| 22 | 3288 | 619·6 | 3639 | 881 | 61 | 9057 | 6330 | 12536 | 1026 |
| 23 | 3423 | 675·7 | 3805 | 880 | 62 | 9242 | 6671 | 12912 | 1035 |
| 24 | 3558 | 734·3 | 3972 | 879 | 63 | 9431 | 7033 | 13305 | 1044 |
| 25 | 3693 | 795·7 | 4141 | 878 | 64 | 9623 | 7418 | 13715 | 1054 |
| 26 | 3827 | 859·9 | 4311 | 878 | 65 | 9819 | 7829 | 14145 | 1064 |
| 27 | 3962 | 926·8 | 4482 | 877 | 66 | 10018 | 8266 | 14595 | 1074 |

IX. (*continued*).

$\lambda = 0{\cdot}6$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 67° | 10221 | 8734 | 15067 | 1084 |
| 68 | 10428 | 9234 | 15564 | 1095 |
| 69 | 10640 | 9770 | 16088 | 1105 |
| 70 | 10855 | 10346 | 16642 | 1116 |
| 71 | 11075 | 10967 | 17228 | 1127 |
| 72 | 11298 | 11636 | 17852 | 1138 |
| 73 | 11527 | 12361 | 18516 | 1150 |
| 74 | 11760 | 13147 | 19226 | 1161 |
| 75 | 11997 | 14004 | 19988 | 1172 |
| 76 | 12239 | 14940 | 20809 | 1183 |
| 77 | 12486 | 15968 | 21698 | 1194 |
| 78 | 12737 | 17102 | 22666 | 1205 |
| 79 | 12993 | 18360 | 23726 | 1216 |
| 80 | 13253 | 19765 | 24897 | 1226 |

$\lambda = 0{\cdot}65$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 34½° | 21805 | 10898 | 11170 | 6030 |
| 34¼ | 20392 | 9932 | 10869 | 5379 |
| 34 | 19244 | 9153 | 10599 | 4901 |
| 33¾ | 18276 | 8504 | 10352 | 4530 |
| 33½ | 17441 | 7948 | 10122 | 4231 |
| 33¼ | 16705 | 7463 | 9908 | 3985 |
| 33 | 16049 | 7035 | 9706 | 3776 |
| 32¾ | 15457 | 6652 | 9514 | 3597 |
| 32½ | 14917 | 6307 | 9332 | 3440 |
| 32¼ | 14421 | 5992 | 9158 | 3302 |
| 32 | 13963 | 5705 | 8991 | 3180 |
| 31¾ | 13538 | 5440 | 8831 | 3069 |
| 31½ | 13140 | 5195 | 8676 | 2969 |
| 31¼ | 12767 | 4968 | 8527 | 2879 |
| 31 | 12416 | 4756 | 8382 | 2796 |
| 30 | 11187 | 4031 | 7845 | 2522 |
| 29 | 10170 | 3455 | 7361 | 2315 |
| 28 | 9302 | 2984 | 6918 | 2150 |

$\lambda = 0{\cdot}65$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 27° | 8546 | 2590 | 6508 | 2016 |
| 26 | 7877 | 2256 | 6126 | 1904 |
| 25 | 7276 | 1970 | 5768 | 1808 |
| 24 | 6732 | 1722 | 5429 | 1725 |
| 23 | 6235 | 1505 | 5108 | 1653 |
| 22 | 5776 | 1315 | 4802 | 1589 |
| 21 | 5352 | 1148 | 4509 | 1532 |
| 20 | 4956 | 1000 | 4228 | 1481 |
| 19 | 4585 | 868·8 | 3959 | 1434 |
| 18 | 4237 | 752·1 | 3699 | 1392 |
| 17 | 3908 | 648·4 | 3447 | 1354 |
| 16 | 3596 | 556·0 | 3204 | 1319 |
| 15 | 3300 | 473·9 | 2968 | 1287 |

$\lambda = 0{\cdot}7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 33¼° | 24731 | 12342 | 11197 | 8443 |
| 33 | 22230 | 10709 | 10803 | 6832 |
| 32¾ | 20481 | 9579 | 10475 | 5889 |
| 32½ | 19135 | 8717 | 10187 | 5250 |
| 32¼ | 18041 | 8024 | 9928 | 4782 |
| 32 | 17120 | 7445 | 9692 | 4420 |
| 31¾ | 16324 | 6951 | 9472 | 4128 |
| 31½ | 15625 | 6520 | 9267 | 3887 |
| 31¼ | 15000 | 6139 | 9074 | 3683 |
| 31 | 14437 | 5799 | 8891 | 3508 |
| 30¾ | 13924 | 5492 | 8716 | 3355 |
| 30½ | 13452 | 5213 | 8550 | 3221 |
| 30¼ | 13017 | 4957 | 8390 | 3101 |
| 30 | 12612 | 4722 | 8236 | 2993 |
| 29¾ | 12234 | 4505 | 8088 | 2896 |
| 29½ | 11879 | 4303 | 7945 | 2807 |
| 29¼ | 11545 | 4115 | 7807 | 2726 |
| 29 | 11230 | 3940 | 7672 | 2652 |
| 28 | 10118 | 3336 | 7171 | 2404 |

IX. (*continued*).

| $\lambda = 0{\cdot}7$ | | | | | $\lambda = 0{\cdot}7$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v')$ |
| 27° | 9190 | 2852 | 6718 | 2214 | 13° | 1999 | 220·0 | 2147 | 891 |
| 26 | 8393 | 2455 | 6301 | 2063 | 14 | 2137 | 253·1 | 2306 | 886 |
| 25 | 7696 | 2122 | 5915 | 1938 | 15 | 2274 | 288·3 | 2466 | 881 |
| 24 | 7077 | 1840 | 5553 | 1833 | 16 | 2409 | 325·7 | 2625 | 877 |
| 23 | 6519 | 1597 | 5213 | 1743 | 17 | 2542 | 365·3 | 2784 | 873 |
| 22 | 6013 | 1388 | 4891 | 1666 | 18 | 2675 | 407·1 | 2943 | 869 |
| 21 | 5548 | 1205 | 4585 | 1597 | 19 | 2806 | 451·0 | 3103 | 865 |
| 20 | 5120 | 1044 | 4293 | 1537 | 20 | 2937 | 497·2 | 3263 | 863 |
| 19 | 4722 | 903·6 | 4014 | 1483 | 21 | 3066 | 545·7 | 3424 | 860 |
| 18 | 4351 | 779·4 | 3745 | 1435 | 22 | 3195 | 596·4 | 3585 | 858 |
| 17 | 4003 | 669·6 | 3487 | 1391 | 23 | 3323 | 649·4 | 3747 | 856 |
| 16 | 3675 | 572·4 | 3237 | 1351 | 24 | 3451 | 704·9 | 3909 | 854 |
| 15 | 3365 | 486·5 | 2996 | 1314 | 25 | 3578 | 762·8 | 4073 | 852 |
| 14 | 3071 | 410·5 | 2762 | 1281 | 26 | 3704 | 823·2 | 4238 | 851 |
| 13 | 2792 | 343·4 | 2535 | 1250 | 27 | 3831 | 886·1 | 4403 | 850 |
| 12 | 2525 | 284·2 | 2314 | 1222 | 28 | 3957 | 951·7 | 4571 | 849 |
| 11 | 2270 | 232·4 | 2099 | 1196 | 29 | 4082 | 1020 | 4739 | 849 |
| 10 | 2026 | 187·1 | 1889 | 1171 | 30 | 4208 | 1091 | 4909 | 849 |
| 9 | 1791 | 147·8 | 1683 | 1148 | 31 | 4334 | 1165 | 5081 | 849 |
| 8 | 1565 | 114·0 | 1483 | 1127 | 32 | 4460 | 1242 | 5255 | 849 |
| 7 | 1347 | 85·3 | 1286 | 1107 | 33 | 4585 | 1323 | 5431 | 850 |
| 6 | 1137 | 61·3 | 1093 | 1039 | 34 | 4712 | 1406 | 5609 | 851 |
| 5 | 933 | 41·7 | 904 | 1072 | 35 | 4838 | 1493 | 5789 | 852 |
| 4 | 736 | 26·2 | 717 | 1055 | 36 | 4965 | 1583 | 5972 | 853 |
| 3 | 544 | 14·4 | 534 | 1040 | 37 | 5092 | 1677 | 6157 | 854 |
| 2 | 358 | 6·3 | 354 | 1026 | 38 | 5219 | 1775 | 6345 | 856 |
| 1 | 177 | 1·5 | 176 | 1013 | 39 | 5348 | 1877 | 6536 | 858 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 172 | 1·5 | 173 | 988 | 40 | 5477 | 1984 | 6731 | 861 |
| 2 | 341 | 5·9 | 345 | 977 | 41 | 5606 | 2094 | 6928 | 863 |
| 3 | 506 | 13·1 | 515 | 967 | 42 | 5737 | 2210 | 7130 | 866 |
| 4 | 667 | 23·0 | 683 | 957 | 43 | 5868 | 2330 | 7335 | 869 |
| 5 | 825 | 35·4 | 850 | 947 | 44 | 6001 | 2456 | 7545 | 872 |
| 6 | 980 | 50·3 | 1015 | 939 | 45 | 6134 | 2587 | 7759 | 876 |
| 7 | 1133 | 67·7 | 1179 | 931 | 46 | 6268 | 2724 | 7977 | 880 |
| 8 | 1283 | 87·4 | 1342 | 923 | 47 | 6404 | 2867 | 8201 | 884 |
| 9 | 1430 | 109·5 | 1504 | 916 | 48 | 6541 | 3016 | 8430 | 888 |
| 10 | 1575 | 133·8 | 1666 | 909 | 49 | 6679 | 3173 | 8664 | 893 |
| 11 | 1719 | 160·3 | 1827 | 903 | 50 | 6819 | 3336 | 8905 | 897 |
| 12 | 1860 | 189·1 | 1987 | 897 | 51 | 6961 | 3508 | 9152 | 902 |

## IX. (*continued*).

$\lambda = 0{\cdot}7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 52° | 7104 | 3688 | 9405 | 908 |
| 53 | 7248 | 3876 | 9666 | 913 |
| 54 | 7395 | 4074 | 9935 | 919 |
| 55 | 7543 | 4282 | 10212 | 925 |
| 56 | 7693 | 4501 | 10498 | 932 |
| 57 | 7846 | 4732 | 10794 | 938 |
| 58 | 8000 | 4974 | 11100 | 945 |
| 59 | 8157 | 5231 | 11417 | 952 |
| 60 | 8317 | 5501 | 11745 | 959 |
| 61 | 8479 | 5787 | 12087 | 967 |
| 62 | 8643 | 6090 | 12442 | 975 |
| 63 | 8810 | 6412 | 12812 | 983 |
| 64 | 8980 | 6752 | 13198 | 991 |
| 65 | 9153 | 7115 | 13601 | 999 |
| 66 | 9329 | 7501 | 14024 | 1008 |
| 67 | 9508 | 7912 | 14467 | 1017 |
| 68 | 9690 | 8352 | 14933 | 1026 |
| 69 | 9875 | 8822 | 15424 | 1035 |
| 70 | 10064 | 9327 | 15942 | 1044 |
| 71 | 10256 | 9870 | 16491 | 1054 |
| 72 | 10451 | 10454 | 17073 | 1063 |
| 73 | 10651 | 11086 | 17693 | 1073 |
| 74 | 10853 | 11771 | 18356 | 1083 |
| 75 | 11060 | 12516 | 19066 | 1092 |
| 76 | 11270 | 13328 | 19831 | 1102 |
| 77 | 11483 | 14219 | 20659 | 1111 |
| 78 | 11701 | 15200 | 21560 | 1121 |
| 79 | 11922 | 16288 | 22546 | 1130 |
| 80 | 12146 | 17501 | 23633 | 1139 |

$\lambda = 0{\cdot}75$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 31° | 18513 | 8007 | 9693 | 5376 |
| 30¾ | 17376 | 7327 | 9433 | 4855 |
| 30½ | 16433 | 6768 | 9197 | 4460 |
| 30¼ | 15626 | 6296 | 8980 | 4147 |
| 30 | 14922 | 5887 | 8777 | 3892 |

$\lambda = 0{\cdot}75$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 29¾° | 14298 | 5528 | 8587 | 3678 |
| 29½ | 13737 | 5209 | 8407 | 3496 |
| 29¼ | 13228 | 4923 | 8236 | 3338 |
| 29 | 12762 | 4663 | 8073 | 3199 |
| 28¾ | 12333 | 4426 | 7917 | 3076 |
| 28½ | 11935 | 4209 | 7766 | 2966 |
| 28¼ | 11564 | 4009 | 7622 | 2867 |
| 28 | 11217 | 3823 | 7482 | 2777 |
| 27 | 10014 | 3196 | 6966 | 2486 |
| 26 | 9030 | 2706 | 6503 | 2269 |
| 25 | 8199 | 2309 | 6081 | 2100 |
| 24 | 7480 | 1981 | 5692 | 1964 |
| 23 | 6846 | 1705 | 5329 | 1850 |
| 22 | 6280 | 1470 | 4989 | 1755 |
| 21 | 5768 | 1269 | 4667 | 1672 |
| 20 | 5301 | 1094 | 4363 | 1600 |
| 19 | 4872 | 942·0 | 4072 | 1537 |
| 18 | 4474 | 809·1 | 3795 | 1481 |
| 17 | 4105 | 692·5 | 3528 | 1430 |
| 16 | 3759 | 590·0 | 3272 | 1385 |
| 15 | 3434 | 499·9 | 3025 | 1344 |

$\lambda = 0{\cdot}8$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 30° | 20497 | 8850 | 9720 | 6999 |
| 29¾ | 18699 | 7817 | 9398 | 5914 |
| 29½ | 17357 | 7054 | 9119 | 5214 |
| 29¼ | 16286 | 6451 | 8871 | 4714 |
| 29 | 15395 | 5955 | 8645 | 4335 |
| 28¾ | 14633 | 5534 | 8437 | 4033 |
| 28½ | 13967 | 5171 | 8243 | 3787 |
| 28¼ | 13376 | 4851 | 8060 | 3580 |
| 28 | 12845 | 4567 | 7887 | 3404 |
| 27¾ | 12362 | 4312 | 7723 | 3251 |
| 27½ | 11920 | 4081 | 7566 | 3116 |
| 27¼ | 11513 | 3870 | 7416 | 2997 |

IX. (*continued*).

| $\lambda = 0{\cdot}8$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 27° | 11135 | 3676 | 7272 | 2891 |
| 26¾ | 10783 | 3498 | 7133 | 2795 |
| 26½ | 10452 | 3332 | 6999 | 2707 |
| 26¼ | 10142 | 3178 | 6869 | 2628 |
| 26 | 9849 | 3035 | 6743 | 2554 |
| 25¾ | 9572 | 2900 | 6621 | 2487 |
| 25½ | 9309 | 2774 | 6502 | 2425 |
| 25¼ | 9059 | 2655 | 6386 | 2367 |
| 25 | 8820 | 2543 | 6274 | 2312 |
| 24 | 7962 | 2152 | 5849 | 2127 |
| 23 | 7228 | 1832 | 5458 | 1980 |
| 22 | 6585 | 1566 | 5096 | 1860 |
| 21 | 6015 | 1341 | 4757 | 1759 |
| 20 | 5502 | 1150 | 4437 | 1672 |
| 19 | 5036 | 984·5 | 4135 | 1597 |
| 18 | 4609 | 841·6 | 3847 | 1532 |
| 17 | 4215 | 717·3 | 3572 | 1474 |
| 16 | 3849 | 608·9 | 3309 | 1422 |
| 15 | 3507 | 514·2 | 3055 | 1376 |
| 14 | 3187 | 431·3 | 2811 | 1334 |
| 13 | 2886 | 358·9 | 2575 | 1296 |
| 12 | 2601 | 295·6 | 2347 | 1261 |
| 11 | 2330 | 240·6 | 2125 | 1229 |
| 10 | 2073 | 192·9 | 1909 | 1200 |
| 9 | 1827 | 151·8 | 1700 | 1173 |
| 8 | 1592 | 116·7 | 1495 | 1148 |
| 7 | 1367 | 87·0 | 1295 | 1124 |
| 6 | 1151 | 62·3 | 1099 | 1103 |
| 5 | 943 | 42·3 | 908 | 1083 |
| 4 | 742 | 26·4 | 720 | 1064 |
| 3 | 547 | 14·6 | 535 | 1046 |
| 2 | 359 | 6·3 | 354 | 1030 |
| 1 | 177 | 1·6 | 176 | 1015 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 0{\cdot}85$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 28¼° | 16942 | 6586 | 8740 | 5392 |
| 28 | 15809 | 5981 | 8488 | 4823 |
| 27¾ | 14885 | 5491 | 8260 | 4402 |
| 27½ | 14103 | 5082 | 8052 | 4075 |
| 27¼ | 13426 | 4732 | 7859 | 3810 |
| 27 | 12830 | 4426 | 7677 | 3591 |
| 26¾ | 12296 | 4156 | 7506 | 3406 |
| 26½ | 11814 | 3914 | 7344 | 3246 |
| 26¼ | 11374 | 3696 | 7189 | 3106 |
| 26 | 10970 | 3497 | 7042 | 2984 |
| 25¾ | 10596 | 3316 | 6900 | 2874 |
| 25½ | 10248 | 3149 | 6763 | 2775 |
| 25¼ | 9923 | 2995 | 6631 | 2686 |
| 25 | 9617 | 2852 | 6504 | 2605 |
| 24 | 8555 | 2367 | 6031 | 2340 |
| 23 | 7682 | 1987 | 5605 | 2142 |
| 22 | 6940 | 1679 | 5216 | 1986 |
| 21 | 6296 | 1426 | 4855 | 1860 |
| 20 | 5726 | 1213 | 4519 | 1755 |
| 19 | 5217 | 1032 | 4202 | 1665 |
| 18 | 4755 | 877·5 | 3903 | 1589 |
| 17 | 4333 | 744·4 | 3619 | 1522 |
| 16 | 3945 | 629·3 | 3347 | 1463 |
| 15 | 3585 | 529·5 | 3087 | 1410 |

| $\lambda = 0{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 27½° | 19528 | 7703 | 8909 | 7561 |
| 27¼ | 17512 | 6658 | 8575 | 6150 |
| 27 | 16090 | 5930 | 8296 | 5315 |
| 26¾ | 14992 | 5373 | 8050 | 4747 |
| 26½ | 14096 | 4924 | 7829 | 4328 |
| 26¼ | 13341 | 4550 | 7627 | 4003 |
| 26 | 12688 | 4229 | 7439 | 3742 |
| 25¾ | 12113 | 3950 | 7262 | 3525 |

IX. (*continued*).

| $\lambda = 0{\cdot}9$ | | | | | $\lambda = 0{\cdot}9$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 25½° | 11599 | 3704 | 7097 | 3342 | 7° | 1109 | 65·8 | 1167 | 912 |
| 25¼ | 11135 | 3484 | 6939 | 3184 | 8 | 1253 | 84·7 | 1326 | 902 |
| 25 | 10712 | 3285 | 6789 | 3047 | 9 | 1393 | 105·7 | 1485 | 893 |
| 24¾ | 10323 | 3105 | 6645 | 2926 | 10 | 1531 | 128·8 | 1642 | 884 |
| 24½ | 9963 | 2940 | 6508 | 2818 | 11 | 1666 | 153·8 | 1798 | 876 |
| 24¼ | 9629 | 2789 | 6375 | 2721 | 12 | 1799 | 180·8 | 1953 | 869 |
| 24 | 9316 | 2649 | 6247 | 2633 | 13 | 1930 | 209·8 | 2108 | 861 |
| 23¾ | 9023 | 2519 | 6123 | 2553 | 14 | 2058 | 240·6 | 2262 | 855 |
| 23½ | 8747 | 2398 | 6004 | 2480 | 15 | 2185 | 273·4 | 2416 | 849 |
| 23¼ | 8486 | 2285 | 5887 | 2413 | 16 | 2310 | 308·0 | 2569 | 843 |
| 23 | 8238 | 2179 | 5774 | 2351 | 17 | 2433 | 344·5 | 2722 | 838 |
| 22 | 7361 | 1816 | 5351 | 2142 | 18 | 2555 | 382·9 | 2875 | 833 |
| 21 | 6621 | 1524 | 4965 | 1981 | 19 | 2675 | 423·1 | 3027 | 828 |
| 20 | 5981 | 1285 | 4608 | 1851 | 20 | 2794 | 465·3 | 3180 | 824 |
| 19 | 5418 | 1085 | 4276 | 1743 | 21 | 2912 | 509·3 | 3333 | 820 |
| 18 | 4916 | 917·1 | 3963 | 1652 | 22 | 3028 | 555·3 | 3487 | 816 |
| 17 | 4462 | 774·0 | 3668 | 1574 | 23 | 3144 | 603·3 | 3641 | 813 |
| 16 | 4049 | 651·4 | 3388 | 1506 | 24 | 3259 | 653·2 | 3795 | 810 |
| 15 | 3668 | 545·8 | 3121 | 1447 | 25 | 3373 | 705·2 | 3950 | 807 |
| 14 | 3316 | 454·8 | 2865 | 1394 | 26 | 3487 | 759·3 | 4106 | 805 |
| 13 | 2989 | 376·1 | 2619 | 1347 | 27 | 3599 | 815·5 | 4263 | 803 |
| 12 | 2682 | 308·1 | 2382 | 1304 | 28 | 3711 | 873·9 | 4420 | 801 |
| 11 | 2394 | 249·5 | 2153 | 1266 | 29 | 3823 | 934·5 | 4579 | 799 |
| 10 | 2123 | 199·1 | 1932 | 1230 | 30 | 3934 | 997·5 | 4739 | 798 |
| 9 | 1865 | 156·0 | 1717 | 1198 | 31 | 4045 | 1063 | 4901 | 797 |
| 8 | 1621 | 119·4 | 1508 | 1169 | 32 | 4156 | 1131 | 5064 | 796 |
| 7 | 1388 | 88·8 | 1305 | 1142 | 33 | 4267 | 1201 | 5228 | 796 |
| 6 | 1165 | 63·4 | 1106 | 1117 | 34 | 4377 | 1274 | 5395 | 795 |
| 5 | 952 | 42·8 | 912 | 1094 | 35 | 4488 | 1350 | 5563 | 795 |
| 4 | 747 | 26·7 | 723 | 1072 | 36 | 4598 | 1429 | 5734 | 795 |
| 3 | 550 | 14·7 | 537 | 1052 | 37 | 4708 | 1511 | 5907 | 796 |
| 2 | 361 | 6·4 | 355 | 1034 | 38 | 4819 | 1595 | 6082 | 796 |
| 1 | 177 | 1·6 | 176 | 1016 | 39 | 4930 | 1684 | 6259 | 797 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 172 | 1·5 | 173 | 985 | 40 | 5041 | 1775 | 6440 | 799 |
| 2 | 339 | 5·9 | 344 | 971 | 41 | 5153 | 1870 | 6623 | 800 |
| 3 | 501 | 12·9 | 512 | 957 | 42 | 5264 | 1969 | 6810 | 801 |
| 4 | 659 | 22·6 | 678 | 945 | 43 | 5377 | 2072 | 7000 | 803 |
| 5 | 813 | 34·7 | 843 | 933 | 44 | 5490 | 2180 | 7193 | 805 |
| 6 | 963 | 49·1 | 1006 | 922 | 45 | 5603 | 2291 | 7391 | 808 |

IX. (*continued*).

| $\lambda = 0{\cdot}9$ | | | | | $\lambda = 0{\cdot}95$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 46° | 5717 | 2407 | 7592 | 810 | 26° | 16125 | 5758 | 8057 | 5724 |
| 47 | 5832 | 2528 | 7798 | 813 | 25¾ | 14878 | 5153 | 7798 | 5007 |
| 48 | 5948 | 2655 | 8008 | 816 | 25½ | 13895 | 4682 | 7569 | 4506 |
| 49 | 6065 | 2787 | 8223 | 819 | 25¼ | 13084 | 4297 | 7361 | 4129 |
| 50 | 6182 | 2924 | 8444 | 823 | 25 | 12395 | 3974 | 7169 | 3832 |
| 51 | 6301 | 3068 | 8670 | 826 | 24¾ | 11794 | 3696 | 6991 | 3592 |
| 52 | 6421 | 3219 | 8902 | 830 | 24½ | 11263 | 3452 | 6823 | 3391 |
| 53 | 6541 | 3376 | 9141 | 834 | 24¼ | 10787 | 3236 | 6665 | 3220 |
| 54 | 6664 | 3541 | 9386 | 838 | 24 | 10355 | 3043 | 6514 | 3073 |
| 55 | 6787 | 3714 | 9639 | 843 | 23¾ | 9961 | 2868 | 6371 | 2944 |
| 56 | 6912 | 3895 | 9899 | 847 | 23½ | 9597 | 2709 | 6234 | 2830 |
| 57 | 7038 | 4086 | 10168 | 852 | 23¼ | 9261 | 2564 | 6102 | 2727 |
| 58 | 7165 | 4286 | 10446 | 857 | 23 | 8947 | 2430 | 5974 | 2636 |
| 59 | 7294 | 4497 | 10733 | 863 | 22 | 7872 | 1984 | 5506 | 2343 |
| 60 | 7425 | 4719 | 11031 | 869 | 21 | 7002 | 1641 | 5087 | 2129 |
| 61 | 7558 | 4953 | 11340 | 874 | 20 | 6273 | 1368 | 4706 | 1964 |
| 62 | 7692 | 5200 | 11661 | 880 | 19 | 5645 | 1146 | 4355 | 1833 |
| 63 | 7828 | 5462 | 11995 | 886 | 18 | 5094 | 961·5 | 4028 | 1724 |
| 64 | 7966 | 5739 | 12343 | 893 | 17 | 4603 | 806·5 | 3721 | 1633 |
| 65 | 8107 | 6033 | 12706 | 899 | 16 | 4160 | 675·3 | 3431 | 1555 |
| 66 | 8249 | 6345 | 13086 | 906 | 15 | 3757 | 563·4 | 3156 | 1487 |
| 67 | 8393 | 6677 | 13484 | 913 | | | | | |
| 68 | 8540 | 7031 | 13902 | 920 | | | | | |
| 69 | 8689 | 7409 | 14342 | 927 | | | | | |
| 70 | 8840 | 7814 | 14806 | 934 | | | | | |
| 71 | 8993 | 8247 | 15296 | 942 | | | | | |
| 72 | 9149 | 8714 | 15817 | 949 | | | | | |
| 73 | 9308 | 9217 | 16370 | 958 | | | | | |
| 74 | 9469 | 9761 | 16960 | 964 | | | | | |
| 75 | 9633 | 10351 | 17593 | 972 | | | | | |

## IX. (*continued*).

| $\gamma = 1{\cdot}0$ | | | | | $\lambda = 1{\cdot}1$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $25\frac{1}{4}°$ | 17685 | 6312 | 8079 | 7314 | $23\frac{1}{4}°$ | 15625 | 5037 | 7305 | 6688 |
| 25 | 15804 | 5430 | 7763 | 5931 | 23 | 14026 | 4353 | 7018 | 5513 |
| $24\frac{3}{4}$ | 14484 | 4818 | 7499 | 5118 | $22\frac{3}{4}$ | 12875 | 3868 | 6775 | 4797 |
| $24\frac{1}{2}$ | 13467 | 4351 | 7267 | 4567 | | | | | |
| $24\frac{1}{4}$ | 12638 | 3976 | 7059 | 4162 | $22\frac{1}{2}$ | 11976 | 3493 | 6561 | 4302 |
| | | | | | $22\frac{1}{4}$ | 11239 | 3189 | 6367 | 3934 |
| 24 | 11940 | 3664 | 6868 | 3848 | 22 | 10614 | 2935 | 6189 | 3646 |
| $23\frac{3}{4}$ | 11337 | 3397 | 6690 | 3595 | | | | | |
| $23\frac{1}{2}$ | 10806 | 3164 | 6524 | 3386 | $21\frac{3}{4}$ | 10071 | 2717 | 6023 | 3413 |
| | | | | | $21\frac{1}{2}$ | 9592 | 2527 | 5867 | 3219 |
| $23\frac{1}{4}$ | 10332 | 2959 | 6368 | 3210 | $21\frac{1}{4}$ | 9163 | 2359 | 5720 | 3055 |
| 23 | 9904 | 2777 | 6219 | 3058 | | | | | |
| $22\frac{3}{4}$ | 9514 | 2612 | 6077 | 2926 | 21 | 8775 | 2209 | 5581 | 2913 |
| | | | | | $20\frac{3}{4}$ | 8421 | 2074 | 5448 | 2790 |
| $22\frac{1}{2}$ | 9156 | 2462 | 5942 | 2809 | $20\frac{1}{2}$ | 8094 | 1951 | 5320 | 2680 |
| $22\frac{1}{4}$ | 8824 | 2326 | 5812 | 2705 | | | | | |
| 22 | 8516 | 2201 | 5687 | 2612 | $20\frac{1}{4}$ | 7792 | 1839 | 5198 | 2583 |
| | | | | | 20 | 7511 | 1736 | 5080 | 2496 |
| $21\frac{3}{4}$ | 8228 | 2085 | 5566 | 2528 | $19\frac{3}{4}$ | 7248 | 1641 | 4966 | 2416 |
| $21\frac{1}{2}$ | 7957 | 1978 | 5449 | 2451 | | | | | |
| $21\frac{1}{4}$ | 7703 | 1878 | 5336 | 2381 | $19\frac{1}{2}$ | 7002 | 1553 | 4856 | 2343 |
| | | | | | $19\frac{1}{4}$ | 6769 | 1471 | 4749 | 2277 |
| 21 | 7462 | 1785 | 5226 | 2317 | 19 | 6549 | 1395 | 4645 | 2216 |
| 20 | 6613 | 1468 | 4815 | 2102 | | | | | |
| 19 | 5903 | 1216 | 4442 | 1938 | 18 | 5771 | 1135 | 4257 | 2013 |
| | | | | | 17 | 5119 | 928·8 | 3903 | 1857 |
| 18 | 5293 | 1012 | 4098 | 1806 | 16 | 4558 | 762·5 | 3577 | 1732 |
| 17 | 4758 | 842·8 | 3777 | 1698 | | | | | |
| 16 | 4281 | 701·6 | 3477 | 1608 | 15 | 4066 | 625·8 | 3273 | 1630 |
| | | | | | 14 | 3627 | 512·3 | 2987 | 1544 |
| 15 | 3852 | 582·5 | 3193 | 1530 | 13 | 3231 | 417·2 | 2717 | 1470 |
| 14 | 3461 | 481·5 | 2923 | 1463 | | | | | |
| 13 | 3103 | 395·4 | 2666 | 1404 | 12 | 2870 | 337·2 | 2460 | 1406 |
| | | | | | 11 | 2539 | 269·8 | 2215 | 1350 |
| 12 | 2772 | 321·9 | 2419 | 1352 | 10 | 2233 | 213·0 | 1979 | 1300 |
| 11 | 2464 | 259·2 | 2183 | 1306 | | | | | |
| 10 | 2176 | 205·8 | 1955 | 1264 | 9 | 1948 | 165·3 | 1753 | 1256 |
| | | | | | 8 | 1682 | 125·5 | 1535 | 1216 |
| 9 | 1905 | 160·5 | 1735 | 1226 | 7 | 1432 | 92·5 | 1325 | 1180 |
| 8 | 1650 | 122·4 | 1521 | 1192 | | | | | |
| 7 | 1409 | 90·6 | 1314 | 1160 | 6 | 1195 | 65·6 | 1120 | 1147 |
| | | | | | 5 | 972 | 44·0 | 922 | 1117 |
| 6 | 1180 | 64·5 | 1113 | 1132 | 4 | 759 | 27·3 | 729 | 1090 |
| 5 | 962 | 43·4 | 917 | 1105 | | | | | |
| 4 | 753 | 27·0 | 726 | 1081 | 3 | 557 | 14·9 | 540 | 1065 |
| | | | | | 2 | 363 | 6·4 | 356 | 1041 |
| 3 | 554 | 14·8 | 539 | 1058 | 1 | 178 | 1·6 | 176 | 1020 |
| 2 | 362 | 6·4 | 356 | 1038 | 0 | 0 | 0 | 0 | 1000 |
| 1 | 178 | 1·6 | 176 | 1018 | 1 | 171 | 1·5 | 173 | 981 |
| 0 | 0 | 0 | 0 | 1000 | 2 | 336 | 5·8 | 343 | 964 |
| | | | | | 3 | 496 | 12·8 | 510 | 948 |

IX. (*continued*).

| $\lambda = 1{\cdot}1$ | | | | | $\lambda = 1{\cdot}1$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 4° | 650 | 22·2 | 674 | 933 | 43° | 4977 | 1869 | 6714 | 751 |
| 5 | 800 | 34·0 | 836 | 919 | 44 | 5075 | 1962 | 6895 | 752 |
| 6 | 946 | 48·0 | 996 | 906 | 45 | 5174 | 2059 | 7079 | 753 |
| 7 | 1087 | 64·1 | 1155 | 894 | 46 | 5273 | 2160 | 7267 | 755 |
| 8 | 1224 | 82·2 | 1311 | 882 | 47 | 5373 | 2265 | 7458 | 757 |
| 9 | 1358 | 102·2 | 1465 | 871 | 48 | 5473 | 2375 | 7654 | 759 |
| 10 | 1489 | 124·1 | 1619 | 861 | 49 | 5574 | 2489 | 7854 | 761 |
| 11 | 1617 | 147·9 | 1771 | 852 | 50 | 5676 | 2608 | 8059 | 764 |
| 12 | 1743 | 173·3 | 1922 | 843 | 51 | 5778 | 2731 | 8269 | 766 |
| 13 | 1865 | 200·5 | 2071 | 834 | 52 | 5881 | 2861 | 8484 | 769 |
| 14 | 1986 | 229·4 | 2221 | 827 | 53 | 5984 | 2996 | 8705 | 772 |
| 15 | 2104 | 260·0 | 2369 | 819 | 54 | 6089 | 3137 | 8932 | 776 |
| 16 | 2220 | 292·2 | 2517 | 812 | 55 | 6194 | 3285 | 9166 | 779 |
| 17 | 2335 | 326·1 | 2664 | 806 | 56 | 6301 | 3440 | 9406 | 783 |
| 18 | 2447 | 361·6 | 2811 | 800 | 57 | 6408 | 3602 | 9654 | 787 |
| 19 | 2558 | 398·7 | 2958 | 794 | 58 | 6517 | 3773 | 9911 | 791 |
| 20 | 2667 | 437·4 | 3104 | 789 | 59 | 6626 | 3952 | 10175 | 795 |
| 21 | 2775 | 477·8 | 3251 | 784 | 60 | 6737 | 4140 | 10449 | 799 |
| 22 | 2882 | 519·9 | 3397 | 780 | 61 | 6849 | 4338 | 10734 | 804 |
| 23 | 2988 | 563·6 | 3544 | 776 | 62 | 6963 | 4547 | 11029 | 809 |
| 24 | 3092 | 609·1 | 3692 | 772 | 63 | 7078 | 4768 | 11335 | 814 |
| 25 | 3196 | 656·2 | 3840 | 768 | 64 | 7194 | 5002 | 11655 | 819 |
| 26 | 3299 | 705·2 | 3988 | 765 | 65 | 7312 | 5249 | 11988 | 824 |
| 27 | 3400 | 755·9 | 4137 | 762 | 66 | 7431 | 5511 | 12336 | 830 |
| 28 | 3501 | 808·5 | 4286 | 760 | 67 | 7552 | 5789 | 12701 | 836 |
| 29 | 3602 | 863·0 | 4437 | 757 | 68 | 7675 | 6086 | 13083 | 841 |
| 30 | 3702 | 919·5 | 4589 | 755 | 69 | 7799 | 6401 | 13485 | 847 |
| 31 | 3801 | 978·0 | 4742 | 753 | 70 | 7926 | 6739 | 13909 | 853 |
| 32 | 3900 | 1039 | 4896 | 752 | | | | | |
| 33 | 3998 | 1101 | 5051 | 751 | | | | | |
| 34 | 4097 | 1166 | 5208 | 750 | | | | | |
| 35 | 4195 | 1234 | 5367 | 749 | | | | | |
| 36 | 4293 | 1303 | 5527 | 748 | | | | | |
| 37 | 4390 | 1376 | 5690 | 748 | | | | | |
| 38 | 4488 | 1451 | 5854 | 748 | | | | | |
| 39 | 4585 | 1528 | 6021 | 748 | | | | | |
| 40 | 4683 | 1609 | 6190 | 748 | | | | | |
| 41 | 4781 | 1692 | 6362 | 749 | | | | | |
| 42 | 4879 | 1779 | 6536 | 750 | | | | | |

| $\lambda = 1{\cdot}2$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 21½° | 13864 | 4059 | 6640 | 6133 |
| 21¼ | 12496 | 3524 | 6378 | 5134 |
| 21 | 11490 | 3135 | 6154 | 4503 |
| 20¾ | 10694 | 2831 | 5954 | 4059 |
| 20½ | 10035 | 2583 | 5773 | 3724 |

IX. (*continued*).

| $\lambda = 1\cdot2$ | | | | | $\lambda = 1\cdot3$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $20\frac{1}{4}°$ | 9473 | 2375 | 5606 | 3460 | $18\frac{3}{4}°$ | 8569 | 1966 | 5127 | 3327 |
| 20 | 8984 | 2195 | 5450 | 3246 | $18\frac{1}{2}$ | 8116 | 1813 | 4978 | 3122 |
| $19\frac{3}{4}$ | 8550 | 2038 | 5304 | 3065 | $18\frac{1}{4}$ | 7714 | 1679 | 4839 | 2951 |
| $19\frac{1}{2}$ | 8161 | 1899 | 5166 | 2912 | 18 | 7354 | 1561 | 4707 | 2804 |
| $19\frac{1}{4}$ | 7807 | 1775 | 5034 | 2780 | $17\frac{3}{4}$ | 7026 | 1456 | 4581 | 2678 |
| 19 | 7484 | 1663 | 4908 | 2664 | $17\frac{1}{2}$ | 6726 | 1360 | 4461 | 2567 |
| $18\frac{3}{4}$ | 7186 | 1561 | 4788 | 2562 | $17\frac{1}{4}$ | 6450 | 1274 | 4346 | 2469 |
| $18\frac{1}{2}$ | 6910 | 1468 | 4672 | 2470 | 17 | 6193 | 1195 | 4235 | 2381 |
| $18\frac{1}{4}$ | 6653 | 1383 | 4561 | 2388 | $16\frac{3}{4}$ | 5954 | 1122 | 4129 | 2302 |
| 18 | 6412 | 1304 | 4453 | 2313 | $16\frac{1}{2}$ | 5730 | 1055 | 4026 | 2230 |
| 17 | 5578 | 1041 | 4053 | 2071 | $16\frac{1}{4}$ | 5520 | 993·5 | 3926 | 2165 |
| 16 | 4895 | 838·2 | 3693 | 1891 | 16 | 5321 | 936·0 | 3829 | 2104 |
| 15 | 4317 | 677·8 | 3363 | 1752 | 15 | 4622 | 742·0 | 3466 | 1906 |
| 14 | 3817 | 548·2 | 3058 | 1639 | 14 | 4039 | 591·1 | 3137 | 1754 |
| 13 | 3375 | 442·1 | 2773 | 1545 | 13 | 3539 | 470·9 | 2833 | 1634 |
| 12 | 2980 | 354·4 | 2503 | 1466 | 12 | 3101 | 373·8 | 2550 | 1536 |
| 11 | 2622 | 281·5 | 2248 | 1399 | 11 | 2712 | 294·5 | 2284 | 1453 |
| 10 | 2295 | 220·9 | 2005 | 1340 | 10 | 2361 | 229·5 | 2033 | 1383 |
| 9 | 1994 | 170·5 | 1773 | 1288 | 9 | 2043 | 176·1 | 1793 | 1322 |
| 8 | 1715 | 128·8 | 1550 | 1241 | 8 | 1750 | 132·3 | 1565 | 1269 |
| 7 | 1455 | 94·5 | 1335 | 1200 | 7 | 1479 | 96·7 | 1346 | 1222 |
| 6 | 1211 | 66·7 | 1128 | 1163 | 6 | 1228 | 68·0 | 1135 | 1180 |
| 5 | 982 | 44·7 | 927 | 1130 | 5 | 993 | 45·3 | 931 | 1142 |
| 4 | 765 | 27·6 | 732 | 1099 | 4 | 772 | 27·9 | 734 | 1108 |
| 3 | 560 | 15·0 | 542 | 1071 | 3 | 563 | 15·1 | 543 | 1078 |
| 2 | 365 | 6·5 | 357 | 1046 | 2 | 366 | 6·5 | 358 | 1049 |
| 1 | 178 | 1·6 | 176 | 1022 | 1 | 179 | 1·6 | 177 | 1024 |
| 0 | 0 | 0 | 0 | 1000 | 0 | 0 | 0 | 0 | 1000 |
| | | | | | 1 | 171 | 1·5 | 173 | 978 |
| | | | | | 2 | 334 | 5·8 | 342 | 958 |
| | | | | | 3 | 491 | 12·6 | 507 | 939 |
| | | | | | 4 | 642 | 21·8 | 670 | 922 |
| | | | | | 5 | 788 | 33·3 | 830 | 906 |
| | | | | | 6 | 929 | 46·9 | 988 | 891 |
| | | | | | 7 | 1065 | 62·4 | 1143 | 877 |
| | | | | | 8 | 1198 | 79·8 | 1296 | 864 |
| | | | | | 9 | 1326 | 99·0 | 1447 | 852 |
| | | | | | 10 | 1451 | 119·9 | 1597 | 840 |
| | | | | | 11 | 1572 | 142·4 | 1745 | 829 |
| | | | | | 12 | 1691 | 166·5 | 1892 | 819 |

| $\lambda = 1\cdot3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 20° | 12597 | 3391 | 6108 | 5844 |
| $19\frac{3}{4}$ | 11351 | 2940 | 5860 | 4910 |
| $19\frac{1}{2}$ | 10428 | 2611 | 5647 | 4316 |
| $19\frac{1}{4}$ | 9696 | 2354 | 5458 | 3896 |
| 19 | 9088 | 2143 | 5286 | 3578 |

IX. (*continued*).

| $\lambda = 1\cdot3$ | | | | | $\lambda = 1\cdot3$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 13° | 1807 | 192·2 | 2038 | 810 | 52° | 5441 | 2578 | 8129 | 720 |
| 14 | 1920 | 219·4 | 2182 | 801 | 53 | 5532 | 2696 | 8335 | 722 |
| 15 | 2031 | 248·1 | 2326 | 793 | 54 | 5623 | 2820 | 8548 | 725 |
| 16 | 2140 | 278·2 | 2469 | 785 | 55 | 5715 | 2949 | 8766 | 728 |
| 17 | 2246 | 309·8 | 2611 | 778 | 56 | 5808 | 3084 | 8991 | 731 |
| 18 | 2351 | 342·8 | 2753 | 771 | 57 | 5902 | 3226 | 9222 | 734 |
| 19 | 2454 | 377·2 | 2894 | 765 | 58 | 5996 | 3374 | 9461 | 737 |
| 20 | 2555 | 413·1 | 3035 | 759 | 59 | 6092 | 3530 | 9708 | 741 |
| 21 | 2655 | 450·4 | 3176 | 753 | 60 | 6188 | 3693 | 9964 | 745 |
| 22 | 2753 | 489·1 | 3317 | 748 | 61 | 6285 | 3865 | 10228 | 748 |
| 23 | 2850 | 529·3 | 3458 | 743 | 62 | 6383 | 4046 | 10503 | 752 |
| 24 | 2946 | 571·0 | 3599 | 739 | 63 | 6483 | 4237 | 10788 | 757 |
| 25 | 3041 | 614·2 | 3740 | 735 | 64 | 6583 | 4439 | 11085 | 761 |
| 26 | 3135 | 658·9 | 3882 | 731 | 65 | 6685 | 4652 | 11394 | 766 |
| 27 | 3228 | 705·1 | 4024 | 727 | | | | | |
| 28 | 3320 | 753·0 | 4167 | 724 | | | | | |
| 29 | 3411 | 802·5 | 4311 | 721 | | | | | |
| 30 | 3502 | 853·7 | 4455 | 719 | | | | | |
| 31 | 3591 | 906·7 | 4600 | 716 | | | | | |
| 32 | 3681 | 961·4 | 4747 | 714 | | | | | |
| 33 | 3770 | 1018 | 4895 | 713 | | | | | |
| 34 | 3858 | 1076 | 5044 | 711 | | | | | |
| 35 | 3946 | 1137 | 5194 | 710 | | | | | |
| 36 | 4034 | 1200 | 5346 | 709 | | | | | |
| 37 | 4121 | 1264 | 5500 | 708 | | | | | |
| 38 | 4209 | 1331 | 5655 | 707 | | | | | |
| 39 | 4296 | 1401 | 5813 | 706 | | | | | |
| 40 | 4383 | 1472 | 5973 | 706 | | | | | |
| 41 | 4470 | 1547 | 6135 | 706 | | | | | |
| 42 | 4557 | 1624 | 6299 | 707 | | | | | |
| 43 | 4644 | 1704 | 6467 | 707 | | | | | |
| 44 | 4731 | 1787 | 6637 | 708 | | | | | |
| 45 | 4819 | 1873 | 6810 | 709 | | | | | |
| 46 | 4907 | 1962 | 6987 | 710 | | | | | |
| 47 | 4995 | 2055 | 7167 | 711 | | | | | |
| 48 | 5083 | 2151 | 7351 | 712 | | | | | |
| 49 | 5172 | 2251 | 7538 | 714 | | | | | |
| 50 | 5261 | 2356 | 7730 | 716 | | | | | |
| 51 | 5351 | 2465 | 7927 | 718 | | | | | |

| $\lambda = 1\cdot4$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 18¾° | 11923 | 3004 | 5724 | 5942 |
| 18½ | 10655 | 2576 | 5476 | 4920 |
| 18¼ | 9736 | 2271 | 5265 | 4291 |
| 18 | 9016 | 2035 | 5079 | 3853 |
| 17¾ | 8424 | 1844 | 4910 | 3527 |
| 17½ | 7921 | 1685 | 4754 | 3271 |
| 17¼ | 7484 | 1548 | 4610 | 3064 |
| 17 | 7098 | 1429 | 4474 | 2891 |
| 16¾ | 6751 | 1324 | 4345 | 2745 |
| 16½ | 6438 | 1230 | 4223 | 2619 |
| 16¼ | 6151 | 1146 | 4107 | 2508 |
| 16 | 5888 | 1070 | 3995 | 2411 |
| 15¾ | 5643 | 1000 | 3888 | 2323 |
| 15½ | 5416 | 936·5 | 3784 | 2245 |
| 15¼ | 5203 | 877·9 | 3684 | 2174 |
| 15 | 5003 | 823·8 | 3587 | 2109 |
| 14 | 4305 | 643·2 | 3227 | 1898 |
| 13 | 3729 | 504·8 | 2901 | 1741 |

IX. (*continued*).

| $\lambda = 1{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 12° | 3239 | 396·0 | 2601 | 1616 |
| 11 | 2812 | 309·1 | 2323 | 1515 |
| 10 | 2434 | 238·9 | 2062 | 1431 |
| 9 | 2095 | 182·1 | 1815 | 1359 |
| 8 | 1787 | 136·0 | 1581 | 1298 |
| 7 | 1505 | 98·9 | 1357 | 1245 |
| 6 | 1245 | 69·2 | 1143 | 1197 |
| 5 | 1004 | 46·0 | 936 | 1155 |
| 4 | 778 | 28·2 | 737 | 1118 |
| 3 | 567 | 15·2 | 545 | 1084 |
| 2 | 368 | 6·5 | 358 | 1053 |
| 1 | 179 | 1·6 | 177 | 1026 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 1{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 17½° | 12110 | 2932 | 5513 | 6843 |
| 17½ | 10532 | 2431 | 5238 | 5333 |
| 17¼ | 9485 | 2103 | 5015 | 4518 |
| 17 | 8701 | 1861 | 4821 | 3989 |
| 16¾ | 8073 | 1671 | 4648 | 3611 |
| 16½ | 7550 | 1515 | 4491 | 3323 |
| 16¼ | 7102 | 1383 | 4345 | 3094 |
| 16 | 6710 | 1270 | 4209 | 2906 |
| 15¾ | 6362 | 1171 | 4081 | 2749 |
| 15½ | 6048 | 1083 | 3959 | 2615 |
| 15¼ | 5763 | 1004 | 3844 | 2499 |
| 15 | 5502 | 933·8 | 3733 | 2396 |
| 14 | 4632 | 708·6 | 3331 | 2085 |
| 13 | 3953 | 545·3 | 2977 | 1870 |
| 12 | 3396 | 421·7 | 2658 | 1710 |
| 11 | 2924 | 325·4 | 2365 | 1585 |
| 10 | 2513 | 249·3 | 2093 | 1484 |
| 9 | 2151 | 188·6 | 1838 | 1400 |
| 8 | 1826 | 140·0 | 1597 | 1329 |
| 7 | 1532 | 101·3 | 1368 | 1269 |

| $\lambda = 1{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 6° | 1263 | 70·6 | 1150 | 1217 |
| 5 | 1015 | 46·6 | 941 | 1169 |
| 4 | 785 | 28·5 | 740 | 1128 |
| 3 | 570 | 15·4 | 546 | 1091 |
| 2 | 369 | 6·6 | 359 | 1058 |
| 1 | 179 | 1·6 | 177 | 1027 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 170 | 1·5 | 172 | 975 |
| 2 | 332 | 5·7 | 341 | 952 |
| 3 | 487 | 12·4 | 505 | 931 |
| 4 | 635 | 21·5 | 666 | 911 |
| 5 | 777 | 32·7 | 824 | 893 |
| 6 | 914 | 45·8 | 979 | 877 |
| 7 | 1046 | 60·8 | 1132 | 861 |
| 8 | 1173 | 77·6 | 1282 | 847 |
| 9 | 1296 | 95·9 | 1430 | 833 |
| 10 | 1415 | 115·9 | 1577 | 820 |
| 11 | 1531 | 137·4 | 1721 | 809 |
| 12 | 1644 | 160·3 | 1864 | 798 |
| 13 | 1753 | 184·6 | 2006 | 787 |
| 14 | 1860 | 210·2 | 2146 | 778 |
| 15 | 1965 | 237·2 | 2286 | 769 |
| 16 | 2067 | 265·5 | 2424 | 760 |
| 17 | 2167 | 295·1 | 2562 | 752 |
| 18 | 2264 | 325·9 | 2699 | 745 |
| 19 | 2360 | 358·0 | 2835 | 738 |
| 20 | 2455 | 391·4 | 2972 | 732 |
| 21 | 2547 | 426·0 | 3107 | 726 |
| 22 | 2638 | 462·0 | 3243 | 720 |
| 23 | 2728 | 499·2 | 3378 | 715 |
| 24 | 2817 | 537·6 | 3514 | 710 |
| 25 | 2904 | 577·5 | 3650 | 705 |
| 26 | 2990 | 618·6 | 3785 | 701 |
| 27 | 3076 | 661·1 | 3922 | 697 |
| 28 | 3160 | 705·0 | 4059 | 693 |
| 29 | 3243 | 750·4 | 4196 | 690 |
| 30 | 3326 | 797·2 | 4334 | 687 |
| 31 | 3408 | 845·6 | 4473 | 684 |
| 32 | 3490 | 895·5 | 4613 | 682 |
| 33 | 3571 | 947·0 | 4754 | 680 |

IX. (*continued*).

$\lambda = 1{\cdot}5$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 34° | 3651 | 1000 | 4896 | 678 |
| 35 | 3731 | 1055 | 5039 | 676 |
| 36 | 3811 | 1112 | 5184 | 675 |
| 37 | 3890 | 1171 | 5330 | 673 |
| 38 | 3969 | 1231 | 5478 | 672 |
| 39 | 4048 | 1294 | 5628 | 671 |
| 40 | 4126 | 1359 | 5780 | 671 |
| 41 | 4205 | 1426 | 5934 | 670 |
| 42 | 4283 | 1495 | 6090 | 670 |
| 43 | 4362 | 1567 | 6249 | 670 |
| 44 | 4440 | 1641 | 6410 | 670 |
| 45 | 4519 | 1718 | 6574 | 671 |
| 46 | 4597 | 1798 | 6741 | 672 |
| 47 | 4676 | 1882 | 6912 | 672 |
| 48 | 4755 | 1968 | 7085 | 673 |
| 49 | 4834 | 2057 | 7263 | 675 |
| 50 | 4914 | 2151 | 7444 | 676 |
| 51 | 4994 | 2248 | 7630 | 678 |
| 52 | 5074 | 2349 | 7820 | 679 |
| 53 | 5155 | 2454 | 8015 | 681 |
| 54 | 5236 | 2564 | 8215 | 683 |
| 55 | 5318 | 2678 | 8421 | 686 |
| 56 | 5400 | 2798 | 8633 | 688 |
| 57 | 5483 | 2923 | 8851 | 691 |
| 58 | 5567 | 3054 | 9076 | 694 |
| 59 | 5651 | 3192 | 9308 | 697 |
| 60 | 5736 | 3337 | 9548 | 700 |

$\lambda = 1{\cdot}6$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $16\frac{1}{2}$° | 9924 | 2153 | 4927 | 5320 |
| $16\frac{1}{4}$ | 8890 | 1849 | 4706 | 4472 |
| 16 | 8125 | 1628 | 4516 | 3932 |
| $15\frac{3}{4}$ | 7517 | 1455 | 4346 | 3550 |
| $15\frac{1}{2}$ | 7013 | 1314 | 4192 | 3260 |
| $15\frac{1}{4}$ | 6582 | 1195 | 4050 | 3032 |

$\lambda = 1{\cdot}6$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 15° | 6206 | 1094 | 3918 | 2845 |
| $14\frac{3}{4}$ | 5872 | 1005 | 3793 | 2689 |
| $14\frac{1}{2}$ | 5572 | 926·8 | 3675 | 2556 |
| $14\frac{1}{4}$ | 5300 | 857·0 | 3562 | 2441 |
| 14 | 5051 | 794·3 | 3455 | 2340 |
| $13\frac{3}{4}$ | 4821 | 737·5 | 3351 | 2251 |
| $13\frac{1}{2}$ | 4608 | 685·9 | 3252 | 2171 |
| $13\frac{1}{4}$ | 4409 | 638·6 | 3157 | 2100 |
| 13 | 4223 | 595·2 | 3064 | 2034 |
| 12 | 3578 | 451·8 | 2720 | 1822 |
| 11 | 3049 | 344·1 | 2410 | 1666 |
| 10 | 2600 | 260·9 | 2126 | 1543 |
| 9 | 2211 | 195·7 | 1862 | 1445 |
| 8 | 1868 | 144·3 | 1614 | 1363 |
| 7 | 1560 | 103·7 | 1381 | 1294 |
| 6 | 1282 | 71·9 | 1159 | 1235 |
| 5 | 1027 | 47·4 | 947 | 1183 |
| 4 | 792 | 28·8 | 744 | 1138 |
| 3 | 574 | 15·5 | 548 | 1098 |
| 2 | 370 | 6·6 | 360 | 1062 |
| 1 | 180 | 1·6 | 177 | 1029 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 1{\cdot}7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $15\frac{1}{2}$° | 8910 | 1789 | 4554 | 4884 |
| $15\frac{1}{4}$ | 8025 | 1545 | 4350 | 4173 |
| 15 | 7352 | 1363 | 4173 | 3702 |
| $14\frac{3}{4}$ | 6810 | 1219 | 4014 | 3362 |
| $14\frac{1}{2}$ | 6356 | 1101 | 3868 | 3100 |
| $14\frac{1}{4}$ | 5965 | 1000 | 3734 | 2891 |
| 14 | 5622 | 914·0 | 3607 | 2720 |
| $13\frac{3}{4}$ | 5316 | 838·6 | 3489 | 2575 |
| $13\frac{1}{2}$ | 5041 | 771·8 | 3376 | 2452 |
| $13\frac{1}{4}$ | 4790 | 712·2 | 3268 | 2344 |
| 13 | 4560 | 658·5 | 3165 | 2250 |

IX. (*continued*).

| $\lambda = 1{\cdot}7$ | | | | | $\lambda = 1{\cdot}7$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 12° | 3793 | 488·1 | 2791 | 1961 | 25° | 2781 | 545·1 | 3567 | 679 |
| 11 | 3191 | 365·6 | 2460 | 1761 | 26 | 2861 | 583·2 | 3697 | 674 |
| 10 | 2697 | 273·8 | 2162 | 1611 | 27 | 2939 | 622·6 | 3829 | 670 |
| 9 | 2277 | 203·5 | 1887 | 1494 | 28 | 3017 | 663·1 | 3960 | 666 |
| 8 | 1913 | 148·9 | 1632 | 1400 | 29 | 3094 | 705·0 | 4092 | 663 |
| 7 | 1590 | 106·4 | 1393 | 1321 | 30 | 3171 | 748·1 | 4225 | 659 |
| 6 | 1301 | 73·4 | 1167 | 1255 | 31 | 3246 | 792·6 | 4358 | 656 |
| 5 | 1039 | 48·1 | 952 | 1198 | 32 | 3321 | 838·5 | 4492 | 654 |
| 4 | 799 | 29·2 | 747 | 1148 | 33 | 3395 | 885·8 | 4627 | 651 |
| 3 | 577 | 15·6 | 550 | 1105 | 34 | 3469 | 934·5 | 4763 | 649 |
| 2 | 372 | 6·6 | 360 | 1066 | 35 | 3542 | 984·9 | 4900 | 647 |
| 1 | 180 | 1·6 | 177 | 1031 | 36 | 3615 | 1037 | 5039 | 645 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 170 | 1·5 | 172 | 972 | 37 | 3688 | 1090 | 5178 | 643 |
| 2 | 330 | 5·7 | 339 | 946 | 38 | 3760 | 1146 | 5320 | 642 |
| 3 | 482 | 12·3 | 503 | 923 | 39 | 3832 | 1203 | 5463 | 641 |
| 4 | 627 | 21·2 | 662 | 901 | 40 | 3903 | 1262 | 5608 | 640 |
| 5 | 766 | 32·0 | 818 | 881 | 41 | 3975 | 1323 | 5754 | 639 |
| 6 | 898 | 44·8 | 971 | 863 | 42 | 4046 | 1386 | 5903 | 639 |
| 7 | 1026 | 59·3 | 1121 | 846 | 43 | 4117 | 1451 | 6055 | 639 |
| 8 | 1148 | 75·5 | 1268 | 830 | 44 | 4188 | 1519 | 6208 | 639 |
| 9 | 1266 | 93·1 | 1414 | 816 | 45 | 4260 | 1589 | 6365 | 639 |
| 10 | 1381 | 112·2 | 1557 | 802 | 46 | 4331 | 1661 | 6524 | 639 |
| 11 | 1491 | 132·7 | 1698 | 790 | 47 | 4402 | 1736 | 6686 | 640 |
| 12 | 1598 | 154·5 | 1838 | 778 | 48 | 4474 | 1814 | 6851 | 640 |
| 13 | 1702 | 177·6 | 1976 | 767 | 49 | 4545 | 1895 | 7020 | 641 |
| 14 | 1804 | 201·9 | 2112 | 756 | 50 | 4617 | 1980 | 7192 | 642 |
| 15 | 1902 | 227·4 | 2248 | 747 | 51 | 4689 | 2067 | 7369 | 643 |
| 16 | 1998 | 254·0 | 2382 | 738 | 52 | 4762 | 2158 | 7549 | 645 |
| 17 | 2092 | 281·8 | 2516 | 729 | 53 | 4834 | 2253 | 7734 | 646 |
| 18 | 2184 | 310·8 | 2649 | 722 | 54 | 4908 | 2352 | 7924 | 648 |
| 19 | 2274 | 340·8 | 2781 | 714 | 55 | 4981 | 2455 | 8119 | 650 |
| 20 | 2362 | 372·1 | 2913 | 707 | 56 | 5055 | 2562 | 8320 | 652 |
| 21 | 2449 | 404·4 | 3044 | 701 | 57 | 5129 | 2675 | 8526 | 654 |
| 22 | 2534 | 437·9 | 3175 | 695 | 58 | 5204 | 2793 | 8739 | 657 |
| 23 | 2617 | 472·5 | 3305 | 689 | 59 | 5280 | 2916 | 8959 | 659 |
| 24 | 2700 | 508·2 | 3436 | 684 | 60 | 5356 | 3045 | 9186 | 662 |

IX. (*continued*).

| $\lambda = 1{\cdot}8$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $14\frac{1}{2}°$ | 7729 | 1417 | 4148 | 4263 |
| $14\frac{1}{4}$ | 7034 | 1239 | 3969 | 3743 |
| 14 | 6484 | 1101 | 3809 | 3376 |
| $13\frac{3}{4}$ | 6029 | 988·2 | 3664 | 3099 |
| $13\frac{1}{2}$ | 5639 | 893·9 | 3530 | 2880 |
| $13\frac{1}{4}$ | 5300 | 813·2 | 3405 | 2702 |
| 13 | 4999 | 743·0 | 3287 | 2553 |
| $12\frac{3}{4}$ | 4729 | 681·2 | 3176 | 2427 |
| $12\frac{1}{2}$ | 4484 | 626·3 | 3070 | 2317 |
| $12\frac{1}{4}$ | 4259 | 577·0 | 2968 | 2221 |
| 12 | 4052 | 532·6 | 2871 | 2136 |
| 11 | 3356 | 390·6 | 2516 | 1873 |
| 10 | 2805 | 288·4 | 2200 | 1688 |
| 9 | 2349 | 212·0 | 1915 | 1549 |
| 8 | 1961 | 153·9 | 1651 | 1439 |
| 7 | 1622 | 109·2 | 1406 | 1350 |
| 6 | 1321 | 74·9 | 1176 | 1276 |
| 5 | 1051 | 48·9 | 957 | 1213 |
| 4 | 806 | 29·5 | 750 | 1159 |
| 3 | 581 | 15·7 | 551 | 1112 |
| 2 | 373 | 6·7 | 361 | 1070 |
| 1 | 180 | 1·6 | 177 | 1033 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 1{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $14°$ | 8142 | 1475 | 4116 | 4980 |
| $13\frac{3}{4}$ | 7240 | 1253 | 3912 | 4170 |
| $13\frac{1}{2}$ | 6576 | 1092 | 3737 | 3659 |
| $13\frac{1}{4}$ | 6051 | 966·5 | 3581 | 3298 |
| 13 | 5616 | 865·0 | 3440 | 3027 |
| $12\frac{3}{4}$ | 5244 | 780·2 | 3310 | 2813 |
| $12\frac{1}{2}$ | 4921 | 707·7 | 3188 | 2638 |
| $12\frac{1}{4}$ | 4634 | 644·7 | 3073 | 2493 |
| 12 | 4376 | 589·4 | 2965 | 2369 |
| 11 | 3548 | 420·6 | 2577 | 2011 |
| 10 | 2926 | 305·1 | 2242 | 1777 |

| $\lambda = 1{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 9° | 2428 | 221·5 | 1944 | 1610 |
| 8 | 2012 | 159·3 | 1671 | 1482 |
| 7 | 1655 | 112·2 | 1420 | 1381 |
| 6 | 1342 | 76·5 | 1185 | 1298 |
| 5 | 1064 | 49·7 | 963 | 1229 |
| 4 | 813 | 29·9 | 753 | 1171 |
| 3 | 585 | 15·9 | 553 | 1119 |
| 2 | 375 | 6·7 | 362 | 1075 |
| 1 | 181 | 1·6 | 178 | 1035 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 169 | 1·5 | 172 | 969 |
| 2 | 328 | 5·6 | 338 | 940 |
| 3 | 478 | 12·1 | 500 | 915 |
| 4 | 620 | 20·8 | 658 | 891 |
| 5 | 755 | 31·5 | 812 | 870 |
| 6 | 884 | 43·9 | 963 | 850 |
| 7 | 1007 | 57·9 | 1111 | 832 |
| 8 | 1126 | 73·5 | 1255 | 815 |
| 9 | 1239 | 90·5 | 1398 | 799 |
| 10 | 1349 | 108·8 | 1538 | 785 |
| 11 | 1454 | 128·4 | 1676 | 772 |
| 12 | 1557 | 149·1 | 1812 | 759 |
| 13 | 1656 | 171·1 | 1947 | 747 |
| 14 | 1752 | 194·2 | 2080 | 737 |
| 15 | 1845 | 218·3 | 2212 | 727 |
| 16 | 1936 | 243·5 | 2343 | 717 |
| 17 | 2025 | 269·8 | 2473 | 708 |
| 18 | 2111 | 297·1 | 2602 | 700 |
| 19 | 2196 | 325·4 | 2730 | 692 |
| 20 | 2279 | 354·7 | 2857 | 685 |
| 21 | 2360 | 385·0 | 2984 | 678 |
| 22 | 2439 | 416·3 | 3111 | 672 |
| 23 | 2517 | 448·7 | 3237 | 666 |
| 24 | 2594 | 482·1 | 3363 | 661 |
| 25 | 2670 | 516·5 | 3490 | 655 |
| 26 | 2744 | 552·0 | 3616 | 651 |
| 27 | 2818 | 588·6 | 3742 | 646 |
| 28 | 2890 | 626·3 | 3869 | 642 |
| 29 | 2962 | 665·1 | 3996 | 638 |
| 30 | 3032 | 705·1 | 4124 | 635 |

## IX. (*continued*).

$\lambda = 1\cdot9$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 31° | 3102 | 746·3 | 4252 | 631 |
| 32 | 3171 | 788·7 | 4381 | 628 |
| 33 | 3240 | 832·4 | 4511 | 626 |
| 34 | 3308 | 877·5 | 4641 | 623 |
| 35 | 3376 | 923·9 | 4773 | 621 |
| 36 | 3443 | 971·7 | 4906 | 619 |
| 37 | 3509 | 1021 | 5040 | 617 |
| 38 | 3576 | 1072 | 5176 | 616 |
| 39 | 3642 | 1124 | 5313 | 614 |
| 40 | 3708 | 1179 | 5452 | 613 |
| 41 | 3773 | 1235 | 5592 | 612 |
| 42 | 3838 | 1293 | 5735 | 612 |
| 43 | 3904 | 1352 | 5880 | 611 |
| 44 | 3969 | 1414 | 6027 | 611 |
| 45 | 4034 | 1478 | 6176 | 611 |
| 46 | 4099 | 1544 | 6328 | 611 |
| 47 | 4164 | 1613 | 6483 | 611 |
| 48 | 4229 | 1684 | 6641 | 612 |
| 49 | 4295 | 1758 | 6802 | 612 |
| 50 | 4360 | 1835 | 6967 | 613 |
| 51 | 4426 | 1914 | 7135 | 614 |
| 52 | 4492 | 1997 | 7308 | 615 |
| 53 | 4558 | 2083 | 7484 | 616 |
| 54 | 4624 | 2173 | 7665 | 618 |
| 55 | 4691 | 2267 | 7851 | 619 |
| 56 | 4758 | 2365 | 8042 | 621 |
| 57 | 4826 | 2467 | 8239 | 623 |

$\lambda = 2\cdot0$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 13° | 6608 | 1068 | 3650 | 3924 |
| 12¾ | 6015 | 932·7 | 3485 | 3471 |
| 12½ | 5540 | 826·1 | 3338 | 3146 |
| 12¼ | 5142 | 738·9 | 3203 | 2897 |
| 12 | 4801 | 665·6 | 3078 | 2700 |
| 11¾ | 4503 | 602·8 | 2962 | 2537 |
| 11½ | 4237 | 548·1 | 2852 | 2401 |

$\lambda = 2\cdot0$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 11¼° | 3998 | 500·0 | 2747 | 2285 |
| 11 | 3780 | 457·2 | 2648 | 2184 |
| 10 | 3065 | 324·4 | 2289 | 1882 |
| 9 | 2515 | 232·1 | 1975 | 1679 |
| 8 | 2068 | 165·1 | 1693 | 1529 |
| 7 | 1691 | 115·4 | 1434 | 1414 |
| 6 | 1365 | 78·2 | 1194 | 1322 |
| 5 | 1077 | 50·5 | 969 | 1245 |
| 4 | 821 | 30·2 | 757 | 1181 |
| 3 | 588 | 16·0 | 555 | 1126 |
| 2 | 376 | 6·7 | 362 | 1079 |
| 1 | 181 | 1·6 | 178 | 1037 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 2\cdot1$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 12½° | 6556 | 1027 | 3544 | 4137 |
| 12¼ | 5909 | 885·1 | 3372 | 3596 |
| 12 | 5404 | 776·7 | 3221 | 3223 |
| 11¾ | 4990 | 689·6 | 3083 | 2947 |
| 11½ | 4639 | 617·4 | 2957 | 2731 |
| 11¼ | 4335 | 556·2 | 2840 | 2556 |
| 11 | 4066 | 503·3 | 2729 | 2411 |
| 10¾ | 3826 | 457·1 | 2625 | 2288 |
| 10½ | 3608 | 416·2 | 2526 | 2183 |
| 10¼ | 3409 | 379·7 | 2431 | 2090 |
| 10 | 3226 | 347·0 | 2340 | 2008 |
| 9 | 2611 | 244·0 | 2009 | 1757 |
| 8 | 2127 | 171·5 | 1715 | 1581 |
| 7 | 1728 | 118·8 | 1449 | 1450 |
| 6 | 1387 | 80·0 | 1203 | 1346 |
| 5 | 1091 | 51·3 | 975 | 1263 |
| 4 | 828 | 30·6 | 760 | 1193 |
| 3 | 592 | 16·2 | 557 | 1134 |
| 2 | 378 | 6·8 | 363 | 1083 |
| 1 | 181 | 1·6 | 178 | 1039 |
| 0 | 0 | 0 | 0 | 1000 |

## IX. (*continued*).

| $\lambda = 2\cdot1$ | | | | | $\lambda = 2\cdot1$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 1° | 169 | 1·5 | 171 | 965 | 40° | 3535 | 1106 | 5310 | 590 |
| 2 | 326 | 5·6 | 337 | 934 | 41 | 3595 | 1158 | 5446 | 589 |
| 3 | 474 | 12·0 | 498 | 906 | 42 | 3656 | 1211 | 5583 | 588 |
| 4 | 613 | 20·5 | 654 | 881 | 43 | 3716 | 1267 | 5722 | 587 |
| 5 | 745 | 30·9 | 807 | 858 | 44 | 3776 | 1324 | 5863 | 587 |
| 6 | 871 | 43·0 | 955 | 837 | 45 | 3836 | 1383 | 6006 | 586 |
| 7 | 990 | 56·6 | 1101 | 818 | 46 | 3896 | 1444 | 6152 | 586 |
| 8 | 1104 | 71·6 | 1243 | 800 | 47 | 3956 | 1507 | 6301 | 586 |
| 9 | 1214 | 88·0 | 1383 | 784 | 48 | 4015 | 1572 | 6452 | 586 |
| 10 | 1319 | 105·6 | 1520 | 769 | 49 | 4076 | 1640 | 6607 | 587 |
| 11 | 1420 | 124·3 | 1655 | 755 | 50 | 4136 | 1710 | 6765 | 587 |
| 12 | 1518 | 144·2 | 1789 | 742 | 51 | 4196 | 1784 | 6926 | 588 |
| 13 | 1612 | 165·1 | 1920 | 730 | 52 | 4257 | 1860 | 7091 | 589 |
| 14 | 1704 | 187·1 | 2050 | 718 | 53 | 4317 | 1939 | 7260 | 590 |
| 15 | 1793 | 210·0 | 2179 | 708 | 54 | 4378 | 2021 | 7433 | 591 |
| 16 | 1879 | 234·0 | 2306 | 698 | 55 | 4439 | 2107 | 7611 | 593 |
| 17 | 1963 | 258·8 | 2432 | 689 | | | | | |
| 18 | 2045 | 284·6 | 2558 | 680 | | | | | |
| 19 | 2125 | 311·3 | 2682 | 672 | | | | | |
| 20 | 2203 | 338·9 | 2806 | 665 | | | | | |
| 21 | 2279 | 367·5 | 2929 | 658 | | | | | |
| 22 | 2354 | 396·9 | 3052 | 651 | | | | | |
| 23 | 2427 | 427·3 | 3174 | 645 | | | | | |
| 24 | 2499 | 458·6 | 3297 | 639 | | | | | |
| 25 | 2570 | 490·9 | 3419 | 634 | | | | | |
| 26 | 2640 | 524·1 | 3541 | 629 | | | | | |
| 27 | 2708 | 558·3 | 3663 | 625 | | | | | |
| 28 | 2776 | 593·5 | 3786 | 620 | | | | | |
| 29 | 2842 | 629·7 | 3908 | 616 | | | | | |
| 30 | 2908 | 667·0 | 4031 | 613 | | | | | |
| 31 | 2973 | 705·3 | 4155 | 609 | | | | | |
| 32 | 3038 | 744·8 | 4279 | 606 | | | | | |
| 33 | 3102 | 785·4 | 4405 | 603 | | | | | |
| 34 | 3165 | 827·3 | 4530 | 600 | | | | | |
| 35 | 3227 | 870·4 | 4657 | 598 | | | | | |
| 36 | 3290 | 914·7 | 4785 | 596 | | | | | |
| 37 | 3351 | 960·5 | 4915 | 594 | | | | | |
| 38 | 3413 | 1008 | 5045 | 592 | | | | | |
| 39 | 3474 | 1056 | 5177 | 591 | | | | | |

| $\lambda = 2\cdot2$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 12° | 6398 | 965·9 | 3419 | 4254 |
| 11⅝ | 5723 | 823·9 | 3243 | 3652 |
| 11½ | 5207 | 717·6 | 3090 | 3249 |
| 11¼ | 4788 | 633·4 | 2952 | 2955 |
| 11 | 4437 | 564·3 | 2826 | 2729 |
| 10⅝ | 4134 | 506·0 | 2709 | 2548 |
| 10½ | 3867 | 456·0 | 2600 | 2398 |
| 10¼ | 3630 | 412·5 | 2496 | 2272 |
| 10 | 3415 | 374·2 | 2398 | 2164 |
| 9 | 2720 | 257·6 | 2045 | 1848 |
| 8 | 2193 | 178·5 | 1739 | 1639 |
| 7 | 1768 | 122·5 | 1464 | 1488 |
| 6 | 1411 | 81·8 | 1213 | 1373 |
| 5 | 1105 | 52·2 | 981 | 1280 |
| 4 | 836 | 31·0 | 763 | 1205 |
| 3 | 596 | 16·3 | 558 | 1142 |
| 2 | 379 | 6·8 | 364 | 1088 |
| 1 | 182 | 1·6 | 178 | 1041 |
| 0 | 0 | 0 | 0 | 1000 |

IX. (*continued*).

| $\lambda = 2\cdot3$ | | | | | $\lambda = 2\cdot3$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $11\frac{1}{2}^\circ$ | 6129 | 885·7 | 3273 | 4248 | 16° | 1826 | 225·2 | 2271 | 681 |
| $11\frac{1}{4}$ | 5459 | 750·9 | 3099 | 3628 | 17 | 1905 | 248·8 | 2394 | 671 |
| 11 | 4951 | 650·9 | 2947 | 3217 | 18 | 1983 | 273·2 | 2516 | 662 |
| $10\frac{3}{4}$ | 4541 | 572·2 | 2811 | 2921 | | | | | |
| | | | | | 19 | 2059 | 298·5 | 2637 | 654 |
| $10\frac{1}{2}$ | 4198 | 507·9 | 2687 | 2693 | 20 | 2132 | 324·6 | 2758 | 646 |
| $10\frac{1}{4}$ | 3903 | 453·9 | 2572 | 2512 | 21 | 2204 | 351·6 | 2877 | 639 |
| 10 | 3645 | 407·7 | 2464 | 2363 | | | | | |
| | | | | | 22 | 2275 | 379·4 | 2997 | 632 |
| $9\frac{3}{4}$ | 3414 | 367·5 | 2362 | 2237 | 23 | 2344 | 408·0 | 3116 | 626 |
| $9\frac{1}{2}$ | 3206 | 332·3 | 2265 | 2130 | 24 | 2412 | 437·5 | 3234 | 620 |
| $9\frac{1}{4}$ | 3017 | 301·0 | 2173 | 2036 | | | | | |
| | | | | | 25 | 2479 | 467·8 | 3352 | 615 |
| 9 | 2843 | 273·1 | 2085 | 1954 | 26 | 2544 | 499·0 | 3471 | 610 |
| 8 | 2264 | 186·3 | 1764 | 1704 | 27 | 2608 | 531·1 | 3589 | 605 |
| 7 | 1810 | 126·4 | 1480 | 1530 | | | | | |
| | | | | | 28 | 2672 | 564·1 | 3708 | 600 |
| 6 | 1437 | 83·8 | 1223 | 1400 | 29 | 2734 | 598·1 | 3827 | 596 |
| 5 | 1120 | 53·2 | 987 | 1299 | 30 | 2796 | 633·0 | 3946 | 593 |
| 4 | 844 | 31·4 | 767 | 1217 | | | | | |
| | | | | | 31 | 2857 | 668·9 | 4066 | 589 |
| 3 | 600 | 16·4 | 560 | 1150 | 32 | 2917 | 705·8 | 4186 | 586 |
| 2 | 381 | 6·8 | 364 | 1092 | 33 | 2977 | 743·7 | 4307 | 583 |
| 1 | 182 | 1·6 | 178 | 1043 | | | | | |
| 0 | 0 | 0 | 0 | 1000 | 34 | 3036 | 782·8 | 4429 | 580 |
| 1 | 168 | 1·4 | 171 | 962 | 35 | 3094 | 823·0 | 4551 | 578 |
| 2 | 324 | 5·5 | 336 | 929 | 36 | 3152 | 864·3 | 4675 | 575 |
| 3 | 470 | 11·9 | 496 | 899 | | | | | |
| | | | | | 37 | 3210 | 906·9 | 4799 | 573 |
| 4 | 606 | 20·2 | 651 | 872 | 38 | 3267 | 950·8 | 4925 | 571 |
| 5 | 735 | 30·4 | 801 | 848 | 39 | 3324 | 996·0 | 5053 | 570 |
| 6 | 857 | 42·1 | 948 | 825 | | | | | |
| | | | | | 40 | 3380 | 1043 | 5181 | 568 |
| 7 | 973 | 55·3 | 1091 | 805 | 41 | 3437 | 1091 | 5312 | 567 |
| 8 | 1084 | 69·8 | 1231 | 786 | 42 | 3493 | 1140 | 5444 | 566 |
| 9 | 1190 | 85·6 | 1368 | 769 | | | | | |
| | | | | | 43 | 3549 | 1191 | 5578 | 565 |
| 10 | 1291 | 102·5 | 1503 | 754 | 44 | 3604 | 1244 | 5714 | 565 |
| 11 | 1388 | 120·6 | 1635 | 739 | 45 | 3660 | 1299 | 5852 | 564 |
| 12 | 1482 | 139·6 | 1766 | 726 | | | | | |
| | | | | | 46 | 3716 | 1356 | 5992 | 564 |
| 13 | 1572 | 159·6 | 1894 | 713 | 47 | 3771 | 1414 | 6135 | 564 |
| 14 | 1659 | 180·6 | 2021 | 701 | 48 | 3827 | 1475 | 6281 | 564 |
| 15 | 1744 | 202·4 | 2147 | 691 | 49 | 3882 | 1537 | 6430 | 564 |
| | | | | | 50 | 3938 | 1603 | 6581 | 565 |

IX. (*continued*).

| $\lambda = 2\cdot4$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 11° | 5760 | 791·7 | 3111 | 4120 |
| 10¾ | 5129 | 670·3 | 2942 | 3528 |
| 10½ | 4647 | 579·9 | 2794 | 3134 |
| 10¼ | 4259 | 508·7 | 2662 | 2848 |
| 10 | 3932 | 450·4 | 2541 | 2628 |
| 9¾ | 3651 | 401·5 | 2428 | 2452 |
| 9½ | 3404 | 359·6 | 2323 | 2308 |
| 9¼ | 3184 | 323·3 | 2224 | 2186 |
| 9 | 2986 | 291·4 | 2130 | 2082 |
| 8¾ | 2805 | 263·2 | 2040 | 1991 |
| 8½ | 2639 | 238·0 | 1954 | 1911 |
| 8¼ | 2486 | 215·4 | 1871 | 1840 |
| 8 | 2343 | 195·0 | 1791 | 1776 |
| 7 | 1856 | 130·7 | 1497 | 1575 |
| 6 | 1464 | 85·9 | 1234 | 1430 |
| 5 | 1135 | 54·1 | 993 | 1319 |
| 4 | 852 | 31·8 | 771 | 1230 |
| 3 | 604 | 16·6 | 562 | 1158 |
| 2 | 382 | 6·9 | 365 | 1097 |
| +1 | 182 | 1·6 | 178 | 1045 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 2\cdot5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 10¼° | 4754 | 586·8 | 2774 | 3370 |
| 10 | 4312 | 507·9 | 2633 | 3010 |
| 9¾ | 3952 | 445·2 | 2506 | 2745 |
| 9½ | 3648 | 393·7 | 2389 | 2540 |
| 9¼ | 3385 | 350·3 | 2281 | 2374 |
| 9 | 3154 | 313·0 | 2179 | 2237 |
| 8¾ | 2947 | 280·7 | 2083 | 2122 |
| 8½ | 2759 | 252·3 | 1991 | 2022 |
| 8¼ | 2589 | 227·2 | 1904 | 1936 |
| 8 | 2432 | 204·7 | 1820 | 1859 |
| 7 | 1906 | 135·3 | 1515 | 1625 |
| 6 | 1492 | 88·1 | 1245 | 1461 |
| 5 | 1151 | 55·1 | 1000 | 1339 |
| 4 | 861 | 32·2 | 774 | 1243 |

| $\lambda = 2\cdot5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 3° | 608 | 16·7 | 564 | 1166 |
| 2 | 384 | 6·9 | 366 | 1101 |
| 1 | 183 | 1·6 | 179 | 1047 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 167 | 1·4 | 171 | 959 |
| 2 | 322 | 5·5 | 335 | 923 |
| 3 | 466 | 11·7 | 493 | 891 |
| 4 | 600 | 19·9 | 647 | 863 |
| 5 | 726 | 29·8 | 796 | 837 |
| 6 | 845 | 41·3 | 940 | 814 |
| 7 | 957 | 54·1 | 1081 | 793 |
| 8 | 1064 | 68·2 | 1219 | 773 |
| 9 | 1166 | 83·4 | 1354 | 756 |
| 10 | 1264 | 99·7 | 1486 | 739 |
| 11 | 1357 | 117·0 | 1616 | 724 |
| 12 | 1447 | 135·3 | 1744 | 710 |
| 13 | 1534 | 154·4 | 1870 | 698 |
| 14 | 1617 | 174·5 | 1994 | 686 |
| 15 | 1698 | 195·4 | 2117 | 675 |
| 16 | 1776 | 217·0 | 2238 | 664 |
| 17 | 1852 | 239·5 | 2358 | 655 |
| 18 | 1926 | 262·8 | 2477 | 646 |
| 19 | 1997 | 286·8 | 2595 | 637 |
| 20 | 2067 | 311·6 | 2712 | 629 |
| 21 | 2136 | 337·1 | 2829 | 622 |
| 22 | 2203 | 363·4 | 2945 | 615 |
| 23 | 2268 | 390·5 | 3060 | 608 |
| 24 | 2332 | 418·3 | 3176 | 603 |
| 25 | 2395 | 447·0 | 3291 | 597 |
| 26 | 2456 | 476·4 | 3406 | 592 |
| 27 | 2517 | 506·6 | 3521 | 587 |
| 28 | 2576 | 537·7 | 3636 | 583 |
| 29 | 2635 | 569·6 | 3751 | 578 |
| 30 | 2693 | 602·4 | 3867 | 574 |
| 31 | 2750 | 636·2 | 3983 | 571 |
| 32 | 2807 | 670·8 | 4099 | 568 |
| 33 | 2863 | 706·4 | 4216 | 564 |
| 34 | 2918 | 743·1 | 4334 | 562 |
| 35 | 2973 | 780·7 | 4453 | 559 |
| 36 | 3027 | 819·4 | 4572 | 557 |

IX. (*continued*).

$\lambda = 2{\cdot}5$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 37° | 3081 | 859·3 | 4693 | 555 |
| 38 | 3134 | 900·3 | 4815 | 553 |
| 39 | 3188 | 942·6 | 4938 | 551 |
| 40 | 3240 | 986·1 | 5062 | 549 |
| 41 | 3293 | 1031 | 5188 | 548 |
| 42 | 3345 | 1077 | 5316 | 547 |
| 43 | 3397 | 1125 | 5445 | 546 |
| 44 | 3449 | 1174 | 5577 | 545 |
| 45 | 3501 | 1225 | 5710 | 545 |
| 46 | 3553 | 1278 | 5846 | 544 |
| 47 | 3604 | 1333 | 5984 | 544 |
| 48 | 3656 | 1389 | 6124 | 544 |
| 49 | 3708 | 1447 | 6267 | 544 |
| 50 | 3760 | 1508 | 6414 | 545 |

$\lambda = 2{\cdot}6$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 10° | 4855 | 592·5 | 2751 | 3627 |
| 9¾ | 4354 | 505·3 | 2601 | 3175 |
| 9½ | 3959 | 438·2 | 2468 | 2859 |
| 9¼ | 3632 | 384·2 | 2347 | 2621 |
| 9 | 3354 | 339·5 | 2235 | 2434 |
| 8¾ | 3112 | 301·7 | 2131 | 2283 |
| 8½ | 2897 | 269·1 | 2033 | 2156 |
| 8¼ | 2704 | 240·8 | 1940 | 2048 |
| 8 | 2530 | 215·8 | 1852 | 1955 |
| 7¾ | 2370 | 193·7 | 1768 | 1874 |
| 7½ | 2223 | 174·0 | 1687 | 1802 |
| 7¼ | 2086 | 156·3 | 1609 | 1737 |
| 7 | 1959 | 140·4 | 1534 | 1679 |
| 6 | 1522 | 90·4 | 1256 | 1495 |
| 5 | 1167 | 56·2 | 1007 | 1360 |
| 4 | 869 | 32·7 | 778 | 1257 |
| 3 | 612 | 16·9 | 566 | 1174 |
| 2 | 385 | 7·0 | 367 | 1106 |
| 1 | 183 | 1·6 | 179 | 1049 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 2{\cdot}7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 9½° | 4383 | 500·1 | 2564 | 3340 |
| 9¼ | 3952 | 428·9 | 2425 | 2966 |
| 9 | 3603 | 372·9 | 2300 | 2695 |
| 8¾ | 3311 | 327·3 | 2186 | 2486 |
| 8½ | 3060 | 289·1 | 2080 | 2320 |
| 8¼ | 2839 | 256·6 | 1981 | 2183 |
| 8 | 2642 | 228·5 | 1887 | 2067 |
| 7¾ | 2465 | 204·0 | 1799 | 1969 |
| 7½ | 2303 | 182·3 | 1714 | 1883 |
| 7¼ | 2154 | 163·1 | 1633 | 1807 |
| 7 | 2017 | 145·9 | 1555 | 1740 |
| 6 | 1553 | 92·9 | 1269 | 1531 |
| 5 | 1185 | 57·3 | 1014 | 1383 |
| 4 | 878 | 33·1 | 782 | 1271 |
| 3 | 616 | 17·0 | 568 | 1183 |
| 2 | 387 | 7·0 | 367 | 1111 |
| 1 | 183 | 1·6 | 179 | 1051 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 167 | 1·4 | 171 | 956 |
| 2 | 320 | 5·4 | 334 | 918 |
| 3 | 461 | 11·6 | 492 | 884 |
| 4 | 593 | 19·6 | 643 | 854 |
| 5 | 716 | 29·3 | 791 | 827 |
| 6 | 832 | 40·5 | 933 | 803 |
| 7 | 942 | 52·9 | 1072 | 781 |
| 8 | 1045 | 66·6 | 1208 | 761 |
| 9 | 1144 | 81·3 | 1341 | 743 |
| 10 | 1238 | 97·0 | 1471 | 726 |
| 11 | 1328 | 113·7 | 1598 | 710 |
| 12 | 1414 | 131·3 | 1723 | 696 |
| 13 | 1497 | 149·7 | 1847 | 683 |
| 14 | 1577 | 168·8 | 1968 | 671 |
| 15 | 1654 | 188·8 | 2088 | 660 |
| 16 | 1729 | 209·5 | 2207 | 649 |
| 17 | 1802 | 230·9 | 2324 | 639 |
| 18 | 1872 | 253·1 | 2440 | 630 |
| 19 | 1940 | 276·0 | 2555 | 622 |
| 20 | 2007 | 299·5 | 2669 | 614 |
| 21 | 2072 | 323·8 | 2783 | 606 |

IX. (*continued*).

$\lambda = 2{\cdot}7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 22° | 2135 | 348·8 | 2896 | 599 |
| 23 | 2197 | 374·4 | 3008 | 593 |
| 24 | 2258 | 400·8 | 3121 | 587 |
| 25 | 2317 | 428·0 | 3233 | 581 |
| 26 | 2376 | 455·8 | 3345 | 576 |
| 27 | 2433 | 484·4 | 3456 | 571 |
| 28 | 2490 | 513·8 | 3568 | 566 |
| 29 | 2545 | 543·9 | 3680 | 562 |
| 30 | 2600 | 574·9 | 3792 | 558 |
| 31 | 2654 | 606·7 | 3905 | 554 |
| 32 | 2707 | 639·3 | 4018 | 551 |
| 33 | 2760 | 672·9 | 4132 | 548 |
| 34 | 2812 | 707·3 | 4246 | 545 |
| 35 | 2863 | 742·8 | 4361 | 542 |
| 36 | 2915 | 779·2 | 4477 | 540 |
| 37 | 2965 | 816·6 | 4594 | 538 |
| 38 | 3015 | 855·2 | 4712 | 536 |
| 39 | 3065 | 894·9 | 4831 | 534 |
| 40 | 3115 | 935·7 | 4952 | 532 |
| 41 | 3164 | 977·8 | 5074 | 531 |
| 42 | 3213 | 1021 | 5197 | 530 |
| 43 | 3262 | 1066 | 5323 | 529 |
| 44 | 3311 | 1112 | 5450 | 528 |
| 45 | 3359 | 1160 | 5579 | 527 |
| 46 | 3408 | 1209 | 5710 | 527 |
| 47 | 3456 | 1260 | 5844 | 526 |
| 48 | 3504 | 1313 | 5980 | 526 |
| 49 | 3553 | 1368 | 6118 | 526 |
| 50 | 3601 | 1424 | 6260 | 526 |

$\lambda = 2{\cdot}8$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $9\frac{1}{2}$° | 5029 | 597·2 | 2691 | 4191 |
| $9\frac{1}{4}$ | 4393 | 492·0 | 2522 | 3496 |
| 9 | 3927 | 417·2 | 2378 | 3062 |
| $8\frac{3}{4}$ | 3559 | 359·7 | 2250 | 2757 |
| $8\frac{1}{2}$ | 3256 | 313·6 | 2133 | 2528 |

$\lambda = 2{\cdot}8$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $8\frac{1}{4}$° | 2997 | 275·5 | 2026 | 2348 |
| 8 | 2771 | 243·3 | 1926 | 2202 |
| $7\frac{3}{4}$ | 2572 | 215·7 | 1832 | 2079 |
| $7\frac{1}{2}$ | 2393 | 191·7 | 1742 | 1976 |
| $7\frac{1}{4}$ | 2230 | 170·7 | 1657 | 1886 |
| 7 | 2081 | 152·1 | 1576 | 1808 |
| 6 | 1588 | 95·6 | 1281 | 1570 |
| 5 | 1203 | 58·5 | 1021 | 1406 |
| 4 | 888 | 33·6 | 786 | 1286 |
| 3 | 621 | 17·2 | 570 | 1191 |
| 2 | 389 | 7·0 | 368 | 1116 |
| 1 | 184 | 1·6 | 179 | 1053 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 2{\cdot}9$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 9° | 4378 | 480·5 | 2475 | 3636 |
| $8\frac{3}{4}$ | 3882 | 402·9 | 2326 | 3141 |
| $8\frac{1}{2}$ | 3498 | 344·7 | 2195 | 2805 |
| $8\frac{1}{4}$ | 3186 | 298·6 | 2077 | 2557 |
| 8 | 2922 | 261·0 | 1969 | 2366 |
| $7\frac{3}{4}$ | 2694 | 229·4 | 1868 | 2212 |
| $7\frac{1}{2}$ | 2493 | 202·5 | 1773 | 2084 |
| $7\frac{1}{4}$ | 2313 | 179·2 | 1684 | 1976 |
| 7 | 2151 | 158·9 | 1599 | 1884 |
| 6 | 1623 | 98·5 | 1294 | 1612 |
| 5 | 1221 | 59·7 | 1028 | 1431 |
| 4 | 897 | 34·1 | 790 | 1301 |
| 3 | 625 | 17·4 | 572 | 1200 |
| 2 | 390 | 7·1 | 369 | 1121 |
| 1 | 184 | 1·6 | 179 | 1055 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 166 | 1·4 | 170 | 953 |
| 2 | 318 | 5·4 | 333 | 912 |
| 3 | 458 | 11·5 | 489 | 877 |

IX. (*continued*).

$\lambda = 2\cdot9$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 4° | 587 | 19·4 | 640 | 846 |
| 5 | 708 | 28·8 | 785 | 817 |
| 6 | 821 | 39·7 | 926 | 792 |
| 7 | 927 | 51·8 | 1064 | 770 |
| 8 | 1028 | 65·1 | 1197 | 749 |
| 9 | 1123 | 79·3 | 1328 | 730 |
| 10 | 1214 | 94·5 | 1455 | 713 |
| 11 | 1301 | 110·6 | 1581 | 697 |
| 12 | 1384 | 127·5 | 1704 | 683 |
| 13 | 1464 | 145·1 | 1824 | 669 |
| 14 | 1540 | 163·6 | 1943 | 657 |
| 15 | 1614 | 182·7 | 2061 | 645 |
| 16 | 1686 | 202·5 | 2177 | 635 |
| 17 | 1755 | 223·0 | 2291 | 625 |
| 18 | 1822 | 244·2 | 2405 | 616 |
| 19 | 1887 | 266·0 | 2517 | 607 |
| 20 | 1951 | 288·5 | 2629 | 599 |
| 21 | 2013 | 311·6 | 2740 | 591 |
| 22 | 2073 | 335·3 | 2850 | 584 |
| 23 | 2132 | 359·8 | 2960 | 578 |
| 24 | 2189 | 384·8 | 3069 | 572 |
| 25 | 2246 | 410·6 | 3178 | 566 |
| 26 | 2302 | 437·0 | 3287 | 561 |
| 27 | 2356 | 464·1 | 3396 | 556 |
| 28 | 2409 | 491·9 | 3505 | 551 |
| 29 | 2462 | 520·4 | 3614 | 547 |
| 30 | 2514 | 549·7 | 3723 | 543 |
| 31 | 2565 | 579·8 | 3833 | 539 |
| 32 | 2615 | 610·7 | 3943 | 536 |
| 33 | 2665 | 642·4 | 4053 | 532 |
| 34 | 2714 | 674·9 | 4164 | 529 |
| 35 | 2763 | 708·4 | 4276 | 527 |
| 36 | 2811 | 742·8 | 4389 | 524 |
| 37 | 2859 | 778·1 | 4502 | 522 |
| 38 | 2906 | 814·5 | 4617 | 520 |
| 39 | 2953 | 851·8 | 4733 | 518 |

$\lambda = 2\cdot9$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 40° | 3000 | 890·3 | 4850 | 516 |
| 41 | 3047 | 930·0 | 4968 | 515 |
| 42 | 3093 | 970·8 | 5088 | 514 |
| 43 | 3139 | 1013 | 5210 | 513 |
| 44 | 3185 | 1056 | 5333 | 512 |
| 45 | 3230 | 1101 | 5458 | 511 |
| 46 | 3276 | 1148 | 5586 | 510 |
| 47 | 3321 | 1196 | 5715 | 510 |
| 48 | 3367 | 1245 | 5847 | 510 |
| 49 | 3412 | 1296 | 5981 | 510 |
| 50 | 3457 | 1350 | 6118 | 510 |

$\lambda = 3\cdot0$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 9° | 5106 | 585·1 | 2606 | 4735 |
| 8½ | 4337 | 465·0 | 2421 | 3748 |
| 8½ | 3816 | 385·9 | 2269 | 3198 |
| 8¼ | 3421 | 327·7 | 2136 | 2835 |
| 8 | 3103 | 282·3 | 2017 | 2573 |
| 7¾ | 2837 | 245·5 | 1909 | 2373 |
| 7½ | 2608 | 214·9 | 1808 | 2213 |
| 7¼ | 2407 | 188·9 | 1713 | 2081 |
| 7 | 2228 | 166·5 | 1624 | 1970 |
| 6 | 1661 | 101·6 | 1308 | 1657 |
| 5 | 1241 | 61·0 | 1036 | 1457 |
| 4 | 907 | 34·6 | 794 | 1316 |
| 3 | 629 | 17·5 | 573 | 1209 |
| 2 | 392 | 7·1 | 370 | 1126 |
| 1 | 184 | 1·6 | 179 | 1057 |
| 0 | 0 | 0 | 0 | 1000 |

IX. (*continued*).

| $\lambda = 3{\cdot}1$ | | | | | $\lambda = 3{\cdot}1$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ | $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $8\frac{3}{4}°$ | 4263 | 445·5 | 2361 | 3823 | 19° | 1838 | 256·8 | 2482 | 593 |
| $8\frac{1}{2}$ | 3727 | 366·5 | 2207 | 3230 | 20 | 1899 | 278·2 | 2591 | 585 |
| 8 | 3327 | 309·3 | 2073 | 2849 | 21 | 1958 | 300·3 | 2699 | 578 |
| $7\frac{3}{4}$ | 3008 | 265·1 | 1954 | 2575 | | | | | |
| | | | | | 22 | 2015 | 323·0 | 2807 | 571 |
| $7\frac{1}{2}$ | 2742 | 229·5 | 1846 | 2368 | 23 | 2071 | 346·2 | 2914 | 564 |
| $7\frac{1}{4}$ | 2514 | 200·0 | 1745 | 2204 | 24 | 2126 | 370·1 | 3021 | 558 |
| 7 | 2315 | 175·1 | 1651 | 2070 | | | | | |
| | | | | | 25 | 2180 | 394·6 | 3127 | 552 |
| $6\frac{3}{4}$ | 2138 | 153·8 | 1563 | 1958 | 26 | 2233 | 419·7 | 3233 | 547 |
| $6\frac{1}{2}$ | 1979 | 135·3 | 1479 | 1862 | 27 | 2284 | 445·5 | 3340 | 542 |
| $6\frac{1}{4}$ | 1835 | 119·2 | 1399 | 1779 | | | | | |
| | | | | | 28 | 2335 | 471·9 | 3446 | 537 |
| 6 | 1702 | 105·0 | 1322 | 1707 | 29 | 2385 | 499·1 | 3552 | 533 |
| 5 | 1262 | 62·3 | 1044 | 1485 | 30 | 2435 | 526·9 | 3659 | 529 |
| 4 | 917 | 35·1 | 798 | 1332 | | | | | |
| | | | | | 31 | 2483 | 555·4 | 3765 | 525 |
| 3 | 634 | 17·7 | 575 | 1219 | 32 | 2531 | 584·7 | 3872 | 521 |
| 2 | 394 | 7·2 | 371 | 1131 | 33 | 2578 | 614·7 | 3980 | 518 |
| 1 | 185 | 1·6 | 180 | 1059 | | | | | |
| 0 | 0 | 0 | 0 | 1000 | 34 | 2625 | 645·6 | 4088 | 515 |
| 1 | 166 | 1·4 | 170 | 950 | 35 | 2671 | 677·3 | 4197 | 513 |
| 2 | 316 | 5·3 | 332 | 907 | 36 | 2716 | 709·8 | 4307 | 510 |
| 3 | 454 | 11·3 | 487 | 870 | | | | | |
| | | | | | 37 | 2761 | 743·2 | 4417 | 508 |
| 4 | 581 | 19·1 | 636 | 837 | 38 | 2806 | 777·6 | 4529 | 506 |
| 5 | 699 | 28·4 | 780 | 808 | 39 | 2851 | 813·0 | 4641 | 504 |
| 6 | 809 | 39·0 | 920 | 782 | | | | | |
| | | | | | 40 | 2895 | 849·3 | 4755 | 502 |
| 7 | 913 | 50·8 | 1055 | 759 | 41 | 2939 | 886·8 | 4870 | 501 |
| 8 | 1011 | 63·6 | 1187 | 738 | 42 | 2982 | 925·4 | 4987 | 499 |
| 9 | 1103 | 77·4 | 1315 | 718 | | | | | |
| | | | | | 43 | 3026 | 965·2 | 5105 | 498 |
| 10 | 1191 | 92·1 | 1441 | 701 | 44 | 3069 | 1006 | 5224 | 497 |
| 11 | 1275 | 107·6 | 1564 | 685 | 45 | 3112 | 1049 | 5346 | 496 |
| 12 | 1355 | 123·9 | 1684 | 670 | | | | | |
| | | | | | 46 | 3155 | 1092 | 5469 | 496 |
| 13 | 1432 | 140·9 | 1803 | 657 | 47 | 3198 | 1137 | 5595 | 495 |
| 14 | 1505 | 158·6 | 1920 | 644 | 48 | 3240 | 1184 | 5723 | 495 |
| 15 | 1577 | 177·0 | 2035 | 632 | | | | | |
| | | | | | 49 | 3283 | 1232 | 5853 | 495 |
| 16 | 1645 | 196·0 | 2148 | 621 | 50 | 3326 | 1282 | 5986 | 495 |
| 17 | 1711 | 215·7 | 2261 | 612 | | | | | |
| 18 | 1776 | 235·9 | 2372 | 602 | | | | | |

IX. (*continued*).

| $\lambda = 3\cdot2$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $8\frac{1}{4}°$ | 4158 | 422·1 | 2295 | 3852 |
| 8 | 3617 | 344·8 | 2140 | 3233 |
| $7\frac{3}{4}$ | 3218 | 289·5 | 2007 | 2840 |
| $7\frac{1}{2}$ | 2901 | 247·1 | 1888 | 2562 |
| $7\frac{1}{4}$ | 2638 | 213·1 | 1780 | 2353 |
| 7 | 2414 | 185·0 | 1680 | 2187 |
| $6\frac{3}{4}$ | 2218 | 161·4 | 1587 | 2052 |
| $6\frac{1}{2}$ | 2045 | 141·2 | 1500 | 1940 |
| $6\frac{1}{4}$ | 1889 | 123·8 | 1417 | 1844 |
| 6 | 1747 | 108·6 | 1338 | 1761 |
| 5 | 1283 | 63·7 | 1052 | 1514 |
| 4 | 927 | 35·6 | 802 | 1349 |
| 3 | 639 | 17·9 | 577 | 1229 |
| 2 | 395 | 7·2 | 371 | 1136 |
| 1 | 185 | 1·6 | 180 | 1061 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 3\cdot3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 8° | 4021 | 395·4 | 2223 | 3834 |
| $7\frac{3}{4}$ | 3487 | 321·4 | 2069 | 3207 |
| $7\frac{1}{2}$ | 3094 | 268·9 | 1937 | 2813 |
| $7\frac{1}{4}$ | 2784 | 228·6 | 1819 | 2535 |
| 7 | 2527 | 196·5 | 1713 | 2326 |
| $6\frac{3}{4}$ | 2308 | 170·0 | 1614 | 2162 |
| $6\frac{1}{2}$ | 2116 | 147·8 | 1522 | 2028 |
| $6\frac{1}{4}$ | 1947 | 128·9 | 1436 | 1916 |
| 6 | 1795 | 112·5 | 1354 | 1821 |
| 5 | 1306 | 65·2 | 1061 | 1546 |
| 4 | 938 | 36·2 | 807 | 1367 |
| 3 | 643 | 18·0 | 580 | 1238 |
| 2 | 397 | 7·2 | 372 | 1141 |
| 1 | 186 | 1·7 | 180 | 1063 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 3\cdot3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 1° | 165 | 1·4 | 170 | 947 |
| 2 | 314 | 5·3 | 331 | 902 |
| 3 | 450 | 11·2 | 485 | 863 |
| 4 | 575 | 18·8 | 633 | 829 |
| 5 | 691 | 27·9 | 776 | 799 |
| 6 | 798 | 38·3 | 913 | 772 |
| 7 | 899 | 49·8 | 1047 | 748 |
| 8 | 994 | 62·2 | 1177 | 727 |
| 9 | 1084 | 75·6 | 1303 | 707 |
| 10 | 1169 | 89·9 | 1427 | 689 |
| 11 | 1250 | 104·9 | 1548 | 673 |
| 12 | 1327 | 120·6 | 1666 | 658 |
| 13 | 1401 | 137·0 | 1783 | 644 |
| 14 | 1472 | 154·0 | 1897 | 632 |
| 15 | 1540 | 171·7 | 2010 | 620 |
| 16 | 1606 | 190·0 | 2121 | 609 |
| 17 | 1670 | 208·8 | 2231 | 599 |
| 18 | 1731 | 228·2 | 2340 | 589 |
| 19 | 1791 | 248·2 | 2448 | 581 |
| 20 | 1849 | 268·8 | 2554 | 573 |
| 21 | 1906 | 289·9 | 2660 | 565 |
| 22 | 1961 | 311·6 | 2766 | 558 |
| 23 | 2014 | 333·8 | 2870 | 551 |
| 24 | 2067 | 356·6 | 2975 | 545 |
| 25 | 2118 | 380·0 | 3078 | 539 |
| 26 | 2168 | 403·9 | 3182 | 534 |
| 27 | 2218 | 428·5 | 3286 | 529 |
| 28 | 2266 | 453·7 | 3389 | 524 |
| 29 | 2314 | 479·5 | 3493 | 520 |
| 30 | 2361 | 506·0 | 3597 | 516 |
| 31 | 2407 | 533·1 | 3701 | 512 |
| 32 | 2452 | 561·0 | 3805 | 508 |
| 33 | 2497 | 589·5 | 3910 | 505 |
| 34 | 2541 | 618·8 | 4016 | 502 |
| 35 | 2585 | 648·9 | 4122 | 499 |
| 36 | 2628 | 679·8 | 4228 | 497 |

IX. (*continued*).

| $\lambda = 3{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $7\frac{3}{4}°$ | 3856 | 366·1 | 2145 | 3769 |
| $7\frac{1}{2}$ | 3340 | 296·9 | 1994 | 3155 |
| $7\frac{1}{4}$ | 2959 | 247·7 | 1864 | 2768 |
| 7 | 2658 | 210·0 | 1749 | 2496 |
| $6\frac{3}{4}$ | 2409 | 180·0 | 1644 | 2290 |
| $6\frac{1}{2}$ | 2197 | 155·3 | 1547 | 2129 |
| $6\frac{1}{4}$ | 2012 | 134·5 | 1456 | 1997 |
| 6 | 1847 | 116·9 | 1371 | 1887 |
| 5 | 1330 | 66·8 | 1070 | 1579 |
| 4 | 949 | 36·7 | 811 | 1385 |
| 3 | 648 | 18·2 | 582 | 1248 |
| 2 | 399 | 7·3 | 373 | 1146 |
| 1 | 186 | 1·7 | 180 | 1065 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 3{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $7\frac{3}{4}°$ | 4428 | 437·1 | 2246 | 4789 |
| $7\frac{1}{2}$ | 3669 | 335·3 | 2063 | 3664 |
| $7\frac{1}{4}$ | 3179 | 271·8 | 1915 | 3080 |
| 7 | 2816 | 226·4 | 1789 | 2709 |
| $6\frac{3}{4}$ | 2527 | 191·6 | 1676 | 2445 |
| $6\frac{1}{2}$ | 2288 | 163·7 | 1573 | 2246 |
| $6\frac{1}{4}$ | 2083 | 140·7 | 1478 | 2089 |
| 6 | 1904 | 121·7 | 1389 | 1961 |
| 5 | 1355 | 68·5 | 1079 | 1614 |
| 4 | 961 | 37·3 | 816 | 1403 |
| 3 | 653 | 18·4 | 584 | 1259 |
| 2 | 401 | 7·3 | 374 | 1151 |
| 1 | 186 | 1·6 | 180 | 1067 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 165 | 1·4 | 170 | 944 |
| 2 | 312 | 5·3 | 330 | 897 |
| 3 | 446 | 11·1 | 483 | 856 |

| $\lambda = 3{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 4° | 569 | 18·6 | 630 | 821 |
| 5 | 682 | 27·5 | 771 | 790 |
| 6 | 788 | 37·6 | 907 | 763 |
| 7 | 886 | 48·8 | 1039 | 738 |
| 8 | 978 | 60·9 | 1167 | 716 |
| 9 | 1065 | 73·9 | 1292 | 696 |
| 10 | 1148 | 87·7 | 1413 | 678 |
| 11 | 1226 | 102·3 | 1532 | 662 |
| 12 | 1301 | 117·4 | 1649 | 647 |
| 13 | 1372 | 133·3 | 1763 | 633 |
| 14 | 1441 | 149·7 | 1875 | 620 |
| 15 | 1507 | 166·7 | 1986 | 608 |
| 16 | 1570 | 184·3 | 2095 | 597 |
| 17 | 1631 | 202·4 | 2203 | 587 |
| 18 | 1690 | 221·1 | 2310 | 578 |
| 19 | 1747 | 240·3 | 2415 | 569 |
| 20 | 1803 | 260·0 | 2520 | 561 |
| 21 | 1857 | 280·2 | 2623 | 553 |
| 22 | 1910 | 301·0 | 2726 | 546 |
| 23 | 1961 | 322·2 | 2829 | 539 |
| 24 | 2012 | 344·0 | 2931 | 533 |
| 25 | 2061 | 366·4 | 3033 | 527 |
| 26 | 2109 | 389·3 | 3134 | 522 |
| 27 | 2156 | 412·8 | 3235 | 517 |
| 28 | 2202 | 436·8 | 3336 | 512 |
| 29 | 2247 | 461·4 | 3438 | 508 |
| 30 | 2292 | 486·7 | 3539 | 504 |
| 31 | 2336 | 512·6 | 3641 | 500 |
| 32 | 2379 | 539·1 | 3743 | 496 |
| 33 | 2422 | 566·3 | 3845 | 493 |
| 34 | 2464 | 594·2 | 3948 | 490 |
| 35 | 2506 | 622·9 | 4051 | 487 |
| 36 | 2547 | 652·3 | 4156 | 485 |

IX. (*continued*).

| $\lambda = 3{\cdot}7$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 7° | 3254 | 273·4 | 1890 | 3375 |
| 6¾ | 2832 | 222·4 | 1753 | 2882 |
| 6½ | 2511 | 185·1 | 1634 | 2556 |
| 6¼ | 2253 | 156·2 | 1527 | 2320 |
| 6 | 2036 | 133·0 | 1430 | 2140 |
| 5¾ | 1850 | 113·8 | 1339 | 1996 |
| 5½ | 1687 | 97·7 | 1254 | 1877 |
| 5¼ | 1541 | 84·0 | 1174 | 1778 |
| 5 | 1410 | 72·2 | 1098 | 1693 |
| 4½ | 1180 | 53·1 | 956 | 1553 |
| 4 | 985 | 38·6 | 825 | 1444 |
| 3½ | 814 | 27·4 | 703 | 1354 |
| 3 | 663 | 18·8 | 588 | 1280 |
| 2½ | 527 | 12·3 | 479 | 1217 |
| 2 | 404 | 7·4 | 375 | 1162 |
| 1½ | 291 | 3·9 | 276 | 1114 |
| 1 | 187 | 1·7 | 181 | 1072 |
| ½ | 90 | 0·4 | 89 | 1034 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 3{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 6½° | 2827 | 216·1 | 1711 | 3043 |
| 6¼ | 2476 | 176·9 | 1586 | 2650 |
| 6 | 2202 | 147·4 | 1476 | 2379 |
| 5¾ | 1976 | 124·2 | 1377 | 2176 |
| 5½ | 1785 | 105·3 | 1285 | 2018 |
| 5¼ | 1618 | 89·7 | 1200 | 1890 |
| 5 | 1471 | 76·4 | 1119 | 1784 |
| 4½ | 1220 | 55·5 | 971 | 1616 |
| 4 | 1011 | 40·0 | 835 | 1488 |
| 3½ | 831 | 28·2 | 710 | 1386 |
| 3 | 674 | 19·2 | 593 | 1303 |
| 2½ | 534 | 12·5 | 482 | 1233 |
| 2 | 407 | 7·5 | 377 | 1173 |

| $\lambda = 3{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 1½° | 293 | 4·0 | 277 | 1121 |
| 1 | 188 | 1·7 | 181 | 1076 |
| ½ | 90 | 0·4 | 89 | 1036 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 164 | 1·4 | 169 | 938 |
| 2 | 309 | 5·2 | 328 | 887 |
| 3 | 439 | 10·9 | 479 | 844 |
| 4 | 558 | 18·1 | 624 | 806 |
| 5 | 667 | 26·7 | 762 | 774 |
| 6 | 768 | 36·3 | 895 | 745 |
| 7 | 861 | 47·0 | 1024 | 720 |
| 8 | 949 | 58·5 | 1148 | 697 |
| 9 | 1031 | 70·8 | 1269 | 676 |
| 10 | 1109 | 83·8 | 1387 | 658 |
| 11 | 1182 | 97·4 | 1503 | 641 |
| 12 | 1252 | 111·6 | 1615 | 626 |
| 13 | 1319 | 126·4 | 1726 | 612 |
| 14 | 1383 | 141·7 | 1834 | 599 |
| 15 | 1444 | 157·6 | 1941 | 587 |
| 16 | 1503 | 173·9 | 2047 | 576 |
| 17 | 1560 | 190·7 | 2150 | 565 |
| 18 | 1615 | 208·0 | 2253 | 556 |
| 19 | 1668 | 225·8 | 2354 | 547 |
| 20 | 1719 | 244·0 | 2455 | 539 |
| 21 | 1769 | 262·6 | 2555 | 531 |
| 22 | 1818 | 281·8 | 2654 | 524 |
| 23 | 1865 | 301·4 | 2752 | 517 |
| 24 | 1911 | 321·4 | 2850 | 511 |
| 25 | 1956 | 342·0 | 2948 | 505 |
| 26 | 2000 | 363·0 | 3045 | 500 |
| 27 | 2043 | 384·6 | 3142 | 495 |
| 28 | 2086 | 406·6 | 3239 | 490 |
| 29 | 2127 | 429·2 | 3336 | 486 |
| 30 | 2168 | 452·3 | 3433 | 482 |
| 31 | 2208 | 476·0 | 3530 | 478 |
| 32 | 2248 | 500·3 | 3627 | 475 |
| 33 | 2287 | 525·1 | 3725 | 471 |
| 34 | 2326 | 550·6 | 3823 | 468 |
| 35 | 2364 | 576·8 | 3922 | 465 |
| 36 | 2401 | 603·6 | 4022 | 463 |

## IX. (*continued*).

| $\lambda = 4{\cdot}1$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $6\frac{1}{4}°$ | 2797 | 207·3 | 1663 | 3179 |
| 6 | 2421 | 166·9 | 1534 | 2721 |
| $5\frac{3}{4}$ | 2135 | 137·4 | 1422 | 2417 |
| $5\frac{1}{2}$ | 1904 | 114·6 | 1321 | 2196 |
| $5\frac{1}{4}$ | 1710 | 96·4 | 1228 | 2027 |
| 5 | 1542 | 81·4 | 1143 | 1891 |
| $4\frac{3}{4}$ | 1396 | 68·8 | 1062 | 1780 |
| $4\frac{1}{2}$ | 1265 | 58·2 | 987 | 1686 |
| 4 | 1039 | 41·4 | 846 | 1536 |
| $3\frac{1}{2}$ | 849 | 29·0 | 717 | 1419 |
| 3 | 685 | 19·6 | 597 | 1326 |
| $2\frac{1}{2}$ | 540 | 12·7 | 485 | 1249 |
| 2 | 411 | 7·6 | 379 | 1184 |
| $1\frac{1}{2}$ | 295 | 4·0 | 278 | 1129 |
| 1 | 188 | 1·7 | 181 | 1080 |
| $0\frac{1}{2}$ | 91 | 0·4 | 89 | 1038 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 4{\cdot}3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 6° | 2737 | 195·8 | 1607 | 3272 |
| $5\frac{3}{4}$ | 2344 | 155·3 | 1476 | 2760 |
| $5\frac{1}{2}$ | 2052 | 126·5 | 1362 | 2432 |
| $5\frac{1}{4}$ | 1819 | 104·5 | 1261 | 2198 |
| 5 | 1625 | 87·1 | 1169 | 2021 |
| $4\frac{3}{4}$ | 1460 | 73·0 | 1083 | 1881 |
| $4\frac{1}{2}$ | 1315 | 61·3 | 1004 | 1766 |
| $4\frac{1}{4}$ | 1186 | 51·4 | 929 | 1670 |
| 4 | 1070 | 43·1 | 857 | 1589 |
| $3\frac{1}{2}$ | 869 | 29·8 | 724 | 1456 |
| 3 | 697 | 20·1 | 602 | 1351 |
| $2\frac{1}{2}$ | 548 | 12·9 | 488 | 1267 |
| 2 | 415 | 7·7 | 380 | 1196 |

| $\lambda = 4{\cdot}3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $1\frac{1}{2}°$ | 297 | 4·1 | 279 | 1136 |
| 1 | 189 | 1·7 | 182 | 1085 |
| $0\frac{1}{2}$ | 91 | 0·4 | 089 | 1040 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 163 | 1·4 | 169 | 933 |
| 2 | 305 | 5·1 | 326 | 877 |
| 3 | 433 | 10·6 | 475 | 831 |
| 4 | 548 | 17·6 | 617 | 792 |
| 5 | 652 | 25·9 | 753 | 758 |
| 6 | 749 | 35·1 | 883 | 728 |
| 7 | 838 | 45·3 | 1009 | 702 |
| 8 | 921 | 56·2 | 1130 | 679 |
| 9 | 999 | 67·9 | 1248 | 658 |
| 10 | 1073 | 80·2 | 1363 | 639 |
| 11 | 1142 | 93·0 | 1475 | 622 |
| 12 | 1208 | 106·4 | 1584 | 606 |
| 13 | 1270 | 120·3 | 1691 | 592 |
| 14 | 1330 | 134·6 | 1797 | 579 |
| 15 | 1388 | 149·5 | 1900 | 567 |
| 16 | 1443 | 164·7 | 2002 | 556 |
| 17 | 1496 | 180·4 | 2102 | 546 |
| 18 | 1547 | 196·5 | 2201 | 536 |
| 19 | 1596 | 213·1 | 2299 | 528 |
| 20 | 1644 | 230·0 | 2396 | 519 |
| 21 | 1690 | 247·3 | 2492 | 512 |
| 22 | 1736 | 265·1 | 2587 | 505 |
| 23 | 1779 | 283·3 | 2682 | 498 |
| 24 | 1822 | 301·9 | 2776 | 492 |
| 25 | 1864 | 320·9 | 2870 | 486 |
| 26 | 1905 | 340·3 | 2963 | 481 |
| 27 | 1944 | 360·2 | 3057 | 476 |
| 28 | 1984 | 380·6 | 3150 | 471 |
| 29 | 2022 | 401·4 | 3243 | 467 |
| 30 | 2060 | 422·7 | 3336 | 463 |

## IX. (*continued*).

$\lambda = 4\cdot5$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $5\frac{3}{4}^{\circ}$ | 2641 | 181·4 | 1544 | 3310 |
| $5\frac{1}{2}$ | 2244 | 142·2 | 1412 | 2764 |
| $5\frac{1}{4}$ | 1953 | 114·8 | 1299 | 2422 |
| 5 | 1722 | 94·1 | 1198 | 2182 |
| $4\frac{3}{4}$ | 1532 | 77·8 | 1107 | 2002 |
| $4\frac{1}{2}$ | 1370 | 64·7 | 1022 | 1860 |
| $4\frac{1}{4}$ | 1228 | 53·9 | 943 | 1744 |
| 4 | 1103 | 44·9 | 869 | 1648 |
| $3\frac{3}{4}$ | 991 | 37·2 | 799 | 1567 |
| $3\frac{1}{2}$ | 889 | 30·8 | 732 | 1495 |
| 3 | 709 | 20·5 | 607 | 1378 |
| $2\frac{1}{2}$ | 554 | 13·1 | 491 | 1285 |
| 2 | 419 | 7·8 | 382 | 1208 |
| $1\frac{1}{2}$ | 299 | 4·1 | 279 | 1144 |
| 1 | 190 | 1·7 | 182 | 1089 |
| $0\frac{1}{2}$ | 91 | 0·4 | 89 | 1042 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 4\cdot7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $1\frac{1}{2}^{\circ}$ | 301 | 4·1 | 280 | 1152 |
| 1 | 191 | 1·7 | 182 | 1094 |
| $0\frac{1}{2}$ | 91 | 0·4 | 89 | 1044 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 162 | 1·4 | 168 | 927 |
| 2 | 302 | 5·0 | 324 | 868 |
| 3 | 426 | 10·4 | 472 | 820 |
| 4 | 538 | 17·2 | 611 | 779 |
| 5 | 639 | 25·1 | 745 | 743 |
| 6 | 731 | 34·0 | 872 | 713 |
| 7 | 816 | 43·7 | 995 | 686 |
| 8 | 896 | 54·2 | 1114 | 662 |
| 9 | 970 | 65·2 | 1228 | 641 |
| 10 | 1039 | 76·9 | 1340 | 622 |
| 11 | 1105 | 89·0 | 1449 | 605 |
| 12 | 1167 | 101·7 | 1555 | 589 |
| 13 | 1226 | 114·8 | 1659 | 575 |
| 14 | 1282 | 128·3 | 1761 | 562 |
| 15 | 1336 | 142·2 | 1861 | 550 |
| 16 | 1388 | 156·5 | 1960 | 539 |
| 17 | 1437 | 171·2 | 2057 | 528 |
| 18 | 1485 | 186·3 | 2153 | 519 |
| 19 | 1531 | 201·7 | 2247 | 510 |
| 20 | 1576 | 217·6 | 2341 | 502 |
| 21 | 1619 | 233·7 | 2434 | 494 |
| 22 | 1661 | 250·3 | 2526 | 487 |
| 23 | 1702 | 267·2 | 2617 | 481 |
| 24 | 1742 | 284·5 | 2708 | 475 |
| 25 | 1781 | 302·2 | 2799 | 469 |
| 26 | 1819 | 320·3 | 2889 | 464 |
| 27 | 1856 | 338·8 | 2979 | 459 |
| 28 | 1892 | 357·7 | 3068 | 454 |
| 29 | 1928 | 377·1 | 3158 | 450 |
| 30 | 1963 | 396·8 | 3248 | 446 |

$\lambda = 4\cdot7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $5\frac{1}{2}^{\circ}$ | 2515 | 165·0 | 1474 | 3286 |
| $5\frac{1}{4}$ | 2125 | 128·3 | 1343 | 2733 |
| 5 | 1841 | 102·7 | 1232 | 2389 |
| $4\frac{3}{4}$ | 1618 | 83·6 | 1133 | 2149 |
| $4\frac{1}{2}$ | 1433 | 68·7 | 1043 | 1969 |
| $4\frac{1}{4}$ | 1276 | 56·7 | 960 | 1828 |
| 4 | 1140 | 46·8 | 882 | 1714 |
| $3\frac{3}{4}$ | 1019 | 38·6 | 809 | 1618 |
| $3\frac{1}{2}$ | 910 | 31·8 | 740 | 1537 |
| $3\frac{1}{4}$ | 812 | 26·0 | 675 | 1467 |
| 3 | 722 | 21·0 | 612 | 1406 |
| $2\frac{1}{2}$ | 562 | 13·3 | 494 | 1304 |
| 2 | 423 | 7·9 | 384 | 1221 |

IX. (*continued*).

$\lambda = 4{\cdot}9$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| $5\frac{1}{4}°$ | 2362 | 147·2 | 1399 | 3205 |
| 5 | 1991 | 113·9 | 1271 | 2668 |
| $4\frac{3}{4}$ | 1720 | 90·7 | 1162 | 2335 |
| $4\frac{1}{2}$ | 1506 | 73·4 | 1065 | 2101 |
| $4\frac{1}{4}$ | 1330 | 59·9 | 977 | 1926 |
| 4 | 1180 | 49·1 | 896 | 1788 |
| $3\frac{3}{4}$ | 1049 | 40·2 | 820 | 1677 |
| $3\frac{1}{2}$ | 934 | 32·9 | 749 | 1584 |
| $3\frac{1}{4}$ | 830 | 26·8 | 682 | 1505 |
| 3 | 735 | 21·6 | 617 | 1436 |
| $2\frac{1}{2}$ | 570 | 13·6 | 497 | 1323 |
| 2 | 427 | 8·0 | 386 | 1234 |
| $1\frac{1}{2}$ | 303 | 4·2 | 281 | 1160 |
| 1 | 191 | 1·7 | 183 | 1098 |
| $0\frac{1}{2}$ | 91 | 0·4 | 89 | 1046 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 5{\cdot}1$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 5° | 2192 | 129·0 | 1319 | 3076 |
| $4\frac{3}{4}$ | 1848 | 99·6 | 1196 | 2578 |
| $4\frac{1}{2}$ | 1594 | 79·0 | 1090 | 2263 |
| $4\frac{1}{4}$ | 1393 | 63·6 | 996 | 2041 |
| 4 | 1226 | 51·5 | 911 | 1874 |
| $3\frac{3}{4}$ | 1084 | 41·9 | 832 | 1742 |
| $3\frac{1}{2}$ | 959 | 34·0 | 758 | 1634 |
| $3\frac{1}{4}$ | 849 | 27·5 | 689 | 1545 |
| 3 | 750 | 22·1 | 623 | 1468 |
| $2\frac{1}{2}$ | 578 | 13·8 | 501 | 1344 |
| 2 | 432 | 8·1 | 388 | 1247 |
| $1\frac{1}{2}$ | 305 | 4·2 | 282 | 1169 |
| 1 | 192 | 1·7 | 183 | 1103 |
| $0\frac{1}{2}$ | 92 | 0·4 | 89 | 1048 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 161 | 1·4 | 167 | 921 |
| 2 | 299 | 5·0 | 323 | 859 |
| 3 | 420 | 10·2 | 468 | 808 |

$\lambda = 5{\cdot}1$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 4° | 528 | 16·8 | 606 | 766 |
| 5 | 625 | 24·5 | 737 | 729 |
| 6 | 714 | 33·0 | 862 | 698 |
| 7 | 796 | 42·3 | 982 | 671 |
| 8 | 872 | 52·3 | 1098 | 647 |
| 9 | 942 | 62·8 | 1210 | 625 |
| 10 | 1008 | 73·9 | 1319 | 606 |
| 11 | 1071 | 85·4 | 1425 | 589 |
| 12 | 1129 | 97·4 | 1529 | 573 |
| 13 | 1185 | 109·8 | 1630 | 559 |
| 14 | 1238 | 122·5 | 1729 | 546 |
| 15 | 1289 | 135·6 | 1826 | 533 |
| 16 | 1338 | 149·1 | 1922 | 522 |
| 17 | 1384 | 163·0 | 2016 | 512 |
| 18 | 1429 | 177·1 | 2109 | 503 |
| 19 | 1473 | 191·6 | 2201 | 494 |
| 20 | 1515 | 206·5 | 2291 | 486 |
| 21 | 1555 | 221·7 | 2381 | 479 |
| 22 | 1595 | 237·2 | 2470 | 472 |
| 23 | 1633 | 253·0 | 2559 | 465 |
| 24 | 1670 | 269·2 | 2647 | 459 |

$\lambda = 5{\cdot}3$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 5° | 2485 | 151·8 | 1380 | 3756 |
| $4\frac{3}{4}$ | 2011 | 111·3 | 1236 | 2919 |
| $4\frac{1}{2}$ | 1698 | 85·9 | 1119 | 2470 |
| $4\frac{1}{4}$ | 1464 | 67·9 | 1018 | 2180 |
| 4 | 1276 | 54·4 | 927 | 1973 |
| $3\frac{3}{4}$ | 1120 | 43·8 | 845 | 1815 |
| $3\frac{1}{2}$ | 986 | 35·3 | 768 | 1690 |
| $3\frac{1}{4}$ | 869 | 28·4 | 697 | 1588 |
| 3 | 765 | 22·7 | 629 | 1502 |
| $2\frac{1}{2}$ | 586 | 14·1 | 504 | 1366 |
| 2 | 436 | 8·2 | 390 | 1261 |
| $1\frac{1}{2}$ | 307 | 4·2 | 283 | 1177 |
| 1 | 193 | 1·7 | 183 | 1108 |
| $0\frac{1}{2}$ | 91 | 0·4 | 89 | 1050 |
| 0 | 0 | 0 | 0 | 1000 |

## IX. (*continued*).

| $\lambda = 5{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $4\frac{3}{4}^{\circ}$ | 2238 | 127·8 | 1287 | 3443 |
| $4\frac{1}{2}$ | 1828 | 94·6 | 1153 | 2746 |
| $4\frac{1}{4}$ | 1547 | 73·1 | 1042 | 2352 |
| 4 | 1333 | 57·7 | 945 | 2089 |
| $3\frac{3}{4}$ | 1161 | 46·0 | 858 | 1899 |
| $3\frac{1}{2}$ | 1016 | 36·7 | 778 | 1753 |
| $3\frac{1}{4}$ | 891 | 29·4 | 704 | 1636 |
| 3 | 781 | 23·4 | 635 | 1539 |
| $2\frac{1}{2}$ | 595 | 14·4 | 508 | 1389 |
| 2 | 440 | 8·3 | 391 | 1275 |
| $1\frac{1}{2}$ | 309 | 4·3 | 284 | 1186 |
| 1 | 194 | 1·8 | 184 | 1113 |
| $0\frac{1}{2}$ | 92 | 0·4 | 90 | 1052 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 160 | 1·4 | 167 | 916 |
| 2 | 296 | 4·9 | 321 | 850 |
| 3 | 414 | 10·0 | 465 | 798 |
| 4 | 519 | 16·4 | 600 | 754 |
| 5 | 613 | 23·8 | 729 | 716 |
| 6 | 699 | 32·0 | 852 | 684 |
| 7 | 777 | 41·0 | 969 | 657 |
| 8 | 850 | 50·5 | 1083 | 632 |
| 9 | 917 | 60·6 | 1192 | 611 |
| 10 | 980 | 71·1 | 1299 | 591 |
| 11 | 1039 | 82·1 | 1402 | 574 |
| 12 | 1095 | 93·4 | 1503 | 558 |
| 13 | 1148 | 105·2 | 1601 | 544 |
| 14 | 1198 | 117·3 | 1698 | 531 |
| 15 | 1247 | 129·7 | 1792 | 519 |
| 16 | 1293 | 142·5 | 1885 | 508 |
| 17 | 1337 | 155·5 | 1977 | 498 |
| 18 | 1379 | 168·9 | 2067 | 488 |
| 19 | 1420 | 182·6 | 2156 | 480 |
| 20 | 1459 | 196·5 | 2244 | 472 |
| 21 | 1497 | 210·8 | 2331 | 464 |
| 22 | 1535 | 225·4 | 2418 | 457 |
| 23 | 1571 | 240·3 | 2503 | 451 |
| 24 | 1606 | 255·5 | 2589 | 445 |

| $\lambda = 5{\cdot}7$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $4\frac{1}{2}^{\circ}$ | 2001 | 106·4 | 1193 | 3143 |
| $4\frac{1}{4}$ | 1650 | 79·5 | 1069 | 2572 |
| 4 | 1401 | 61·5 | 965 | 2229 |
| $3\frac{3}{4}$ | 1207 | 48·4 | 873 | 1995 |
| $3\frac{1}{2}$ | 1049 | 38·3 | 790 | 1822 |
| $3\frac{1}{4}$ | 915 | 30·4 | 713 | 1688 |
| 3 | 799 | 24·1 | 642 | 1579 |
| $2\frac{3}{4}$ | 696 | 18·9 | 575 | 1489 |
| $2\frac{1}{2}$ | 604 | 14·7 | 511 | 1413 |
| 2 | 445 | 8·4 | 394 | 1290 |
| $1\frac{1}{2}$ | 311 | 4·3 | 285 | 1194 |
| 1 | 195 | 1·8 | 184 | 1118 |
| $0\frac{1}{2}$ | 92 | 0·4 | 90 | 1054 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 5{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $4\frac{1}{2}^{\circ}$ | 2247 | 123·6 | 1244 | 3782 |
| $4\frac{1}{4}$ | 1780 | 87·7 | 1101 | 2867 |
| 4 | 1480 | 66·1 | 987 | 2402 |
| $3\frac{3}{4}$ | 1259 | 51·1 | 889 | 2108 |
| $3\frac{1}{2}$ | 1085 | 40·1 | 801 | 1901 |
| $3\frac{1}{4}$ | 940 | 31·5 | 722 | 1745 |
| 3 | 817 | 24·8 | 648 | 1622 |
| $2\frac{3}{4}$ | 709 | 19·4 | 580 | 1521 |
| $2\frac{1}{2}$ | 614 | 15·0 | 515 | 1438 |
| 2 | 450 | 8·6 | 395 | 1305 |
| $1\frac{1}{2}$ | 313 | 4·4 | 286 | 1203 |
| 1 | 195 | 1·8 | 185 | 1122 |
| $0\frac{1}{2}$ | 92 | 0·4 | 90 | 1056 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 159 | 1·3 | 166 | 911 |
| 2 | 293 | 4·8 | 319 | 842 |
| 3 | 408 | 9·8 | 461 | 787 |
| 4 | 510 | 16·0 | 595 | 742 |
| 5 | 601 | 23·2 | 721 | 704 |
| 6 | 683 | 31·1 | 842 | 671 |

IX. (*continued*).

$\lambda = 5{\cdot}9$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 7° | 759 | 39·7 | 957 | 643 |
| 8 | 828 | 48·8 | 1068 | 619 |
| 9 | 893 | 58·5 | 1176 | 597 |
| 10 | 953 | 68·5 | 1279 | 577 |
| 11 | 1009 | 79·0 | 1380 | 560 |
| 12 | 1062 | 89·8 | 1479 | 544 |
| 13 | 1113 | 101·0 | 1575 | 530 |
| 14 | 1161 | 112·4 | 1668 | 517 |
| 15 | 1206 | 124·2 | 1761 | 505 |
| 16 | 1250 | 136·3 | 1851 | 494 |
| 17 | 1291 | 148·7 | 1940 | 484 |
| 18 | 1332 | 161·3 | 2028 | 475 |
| 19 | 1370 | 174·3 | 2115 | 466 |
| 20 | 1408 | 187·5 | 2200 | 458 |
| 21 | 1444 | 201·0 | 2285 | 451 |
| 22 | 1479 | 214·7 | 2369 | 444 |
| 23 | 1513 | 228·8 | 2452 | 438 |
| 24 | 1546 | 243·2 | 2535 | 432 |

$\lambda = 6{\cdot}1$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 4¼° | 1949 | 98·7 | 1140 | 3296 |
| 4 | 1574 | 71·7 | 1012 | 2622 |
| 3¾ | 1319 | 54·3 | 906 | 2242 |
| 3½ | 1125 | 42·0 | 814 | 1990 |
| 3¼ | 968 | 32·8 | 731 | 1808 |
| 3 | 836 | 25·6 | 655 | 1668 |
| 2¾ | 723 | 19·9 | 585 | 1556 |
| 2½ | 624 | 15·3 | 519 | 1465 |
| 2 | 455 | 8·7 | 398 | 1321 |
| 1½ | 316 | 4·4 | 287 | 1213 |
| 1 | 196 | 1·8 | 185 | 1127 |
| ½ | 92 | 0·4 | 90 | 1058 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 6{\cdot}3$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 4° | 1693 | 78·8 | 1041 | 2916 |
| 3¾ | 1388 | 58·1 | 925 | 2406 |
| 3½ | 1170 | 44·2 | 827 | 2094 |
| 3¼ | 998 | 34·1 | 741 | 1879 |
| 3 | 857 | 26·4 | 662 | 1719 |
| 2¾ | 738 | 20·4 | 590 | 1594 |
| 2½ | 634 | 15·7 | 523 | 1493 |
| 2 | 460 | 8·8 | 400 | 1337 |
| 1½ | 318 | 4·4 | 288 | 1222 |
| 1 | 197 | 1·8 | 186 | 1132 |
| ½ | 92 | 0·4 | 90 | 1060 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 158 | 1·3 | 166 | 906 |
| 2 | 289 | 4·7 | 318 | 834 |
| 3 | 402 | 9·7 | 458 | 777 |
| 4 | 501 | 15·7 | 590 | 731 |
| 5 | 590 | 22·6 | 714 | 692 |
| 6 | 669 | 30·3 | 833 | 659 |
| 7 | 742 | 38·5 | 946 | 631 |
| 8 | 808 | 47·3 | 1055 | 606 |
| 9 | 870 | 56·5 | 1160 | 584 |
| 10 | 928 | 66·2 | 1261 | 565 |
| 11 | 982 | 76·2 | 1360 | 547 |
| 12 | 1033 | 86·5 | 1456 | 532 |
| 13 | 1081 | 97·1 | 1550 | 517 |
| 14 | 1126 | 108·0 | 1642 | 504 |
| 15 | 1169 | 119·2 | 1731 | 493 |
| 16 | 1211 | 130·7 | 1820 | 482 |
| 17 | 1250 | 142·5 | 1906 | 472 |
| 18 | 1289 | 154·5 | 1992 | 463 |
| 19 | 1325 | 166·8 | 2076 | 454 |
| 20 | 1361 | 179·3 | 2160 | 446 |
| 21 | 1395 | 192·1 | 2242 | 439 |
| 22 | 1428 | 205·1 | 2324 | 432 |
| 23 | 1460 | 218·4 | 2405 | 426 |
| 24 | 1491 | 232·0 | 2486 | 419 |

## IX. (*continued*).

$\lambda = 6{\cdot}7$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 4° | 2073 | 102·5 | 1119 | 4019 |
| 3¾ | 1574 | 68·5 | 972 | 2880 |
| 3½ | 1279 | 49·8 | 859 | 2362 |
| 3¼ | 1068 | 37·3 | 763 | 2049 |
| 3 | 905 | 28·4 | 678 | 1836 |
| 2¾ | 770 | 21·6 | 602 | 1678 |
| 2½ | 657 | 16·4 | 531 | 1554 |
| 2¼ | 558 | 12·3 | 466 | 1455 |
| 2 | 471 | 9·1 | 404 | 1372 |
| 1½ | 323 | 4·5 | 290 | 1242 |
| 1 | 199 | 1·8 | 186 | 1143 |
| 0½ | 93 | 0·4 | 90 | 1064 |
| 0 | 0 | 0 | 0 | 1000 |

$\lambda = 7{\cdot}1$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 3¾° | 1887 | 86·7 | 1039 | 3826 |
| 3½ | 1431 | 57·7 | 898 | 2769 |
| 3¼ | 1157 | 41·5 | 789 | 2278 |
| 3 | 961 | 30·7 | 696 | 1981 |
| 2¾ | 807 | 23·0 | 614 | 1776 |
| 2½ | 682 | 17·2 | 540 | 1624 |
| 2¼ | 575 | 12·8 | 472 | 1505 |
| 2 | 482 | 9·4 | 408 | 1409 |
| 1½ | 327 | 4·6 | 292 | 1262 |
| 1 | 201 | 1·8 | 187 | 1153 |
| 0½ | 93 | 0·4 | 90 | 1068 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 156 | 1·3 | 165 | 895 |
| 2 | 284 | 4·6 | 314 | 818 |
| 3 | 392 | 9·3 | 452 | 758 |
| 4 | 486 | 15·0 | 580 | 710 |
| 5 | 569 | 21·6 | 701 | 670 |
| 6 | 643 | 28·7 | 815 | 637 |

$\lambda = 7{\cdot}1$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 7° | 711 | 36·4 | 924 | 608 |
| 8 | 772 | 44·5 | 1029 | 583 |
| 9 | 829 | 53·0 | 1130 | 561 |
| 10 | 882 | 61·9 | 1227 | 542 |
| 11 | 932 | 71·1 | 1322 | 524 |
| 12 | 978 | 80·5 | 1414 | 509 |
| 13 | 1022 | 90·3 | 1503 | 494 |
| 14 | 1064 | 100·2 | 1591 | 482 |
| 15 | 1103 | 110·5 | 1677 | 470 |
| 16 | 1141 | 120·9 | 1761 | 460 |
| 17 | 1177 | 131·6 | 1844 | 450 |
| 18 | 1212 | 142·5 | 1925 | 441 |
| 19 | 1245 | 153·6 | 2006 | 432 |
| 20 | 1277 | 164·9 | 2085 | 425 |
| 21 | 1308 | 176·5 | 2163 | 418 |
| 22 | 1338 | 188·3 | 2241 | 411 |
| 23 | 1367 | 200·3 | 2318 | 405 |
| 24 | 1395 | 212·6 | 2394 | 399 |

$\lambda = 7{\cdot}5$

| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
|---|---|---|---|---|
| 3½° | 1667 | 70·4 | 951 | 3499 |
| 3¼ | 1274 | 47·0 | 820 | 2606 |
| 3 | 1029 | 33·6 | 717 | 2167 |
| 2¾ | 850 | 24·6 | 628 | 1895 |
| 2½ | 710 | 18·2 | 550 | 1704 |
| 2¼ | 594 | 13·4 | 479 | 1562 |
| 2 | 495 | 9·7 | 413 | 1450 |
| 1½ | 333 | 4·7 | 294 | 1284 |
| 1 | 202 | 1·9 | 188 | 1164 |
| 0½ | 94 | 0·4 | 90 | 1073 |
| 0 | 0 | 0 | 0 | 1000 |

## IX. (*continued*).

| $\lambda = 7{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $3\frac{1}{4}°$ | 1442 | 55·5 | 860 | 3131 |
| 3 | 1115 | 37·4 | 741 | 2418 |
| $2\frac{3}{4}$ | 901 | 26·6 | 644 | 2040 |
| $2\frac{1}{2}$ | 741 | 19·3 | 561 | 1798 |
| $2\frac{1}{4}$ | 614 | 14·0 | 486 | 1625 |
| 2 | 508 | 10·0 | 418 | 1495 |
| $1\frac{1}{2}$ | 338 | 4·8 | 297 | 1307 |
| 1 | 204 | 1·9 | 189 | 1175 |
| $0\frac{1}{2}$ | 94 | 0·4 | 91 | 1077 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 154 | 1·3 | 164 | 885 |
| 2 | 278 | 4·5 | 311 | 803 |
| 3 | 382 | 9·0 | 446 | 741 |
| 4 | 471 | 14·4 | 571 | 691 |
| 5 | 549 | 20·6 | 688 | 650 |
| 6 | 619 | 27·3 | 799 | 616 |
| 7 | 682 | 34·5 | 905 | 587 |
| 8 | 740 | 42·1 | 1006 | 562 |
| 9 | 793 | 50·0 | 1103 | 540 |
| 10 | 842 | 58·2 | 1197 | 521 |
| 11 | 888 | 66·7 | 1288 | 504 |
| 12 | 931 | 75·4 | 1376 | 488 |
| 13 | 971 | 84·3 | 1462 | 474 |
| 14 | 1009 | 93·5 | 1546 | 462 |
| 15 | 1046 | 102·9 | 1628 | 450 |
| 16 | 1080 | 112·5 | 1709 | 440 |
| 17 | 1113 | 122·3 | 1788 | 430 |
| 18 | 1145 | 132·3 | 1866 | 421 |
| 19 | 1175 | 142·4 | 1943 | 313 |
| 20 | 1205 | 152·8 | 2019 | 406 |
| 21 | 1233 | 163·4 | 2094 | 399 |
| 22 | 1260 | 174·1 | 2168 | 392 |
| 23 | 1287 | 185·1 | 2241 | 386 |
| 24 | 1312 | 196·2 | 2315 | 381 |

| $\lambda = 8{\cdot}3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 3° | 1230 | 42·5 | 771 | 2781 |
| $2\frac{3}{4}$ | 962 | 29·0 | 663 | 2226 |
| $2\frac{1}{2}$ | 777 | 20·5 | 573 | 1909 |
| $2\frac{1}{4}$ | 636 | 14·7 | 494 | 1697 |
| 2 | 522 | 10·4 | 424 | 1544 |
| $1\frac{3}{4}$ | 426 | 7·3 | 359 | 1425 |
| $1\frac{1}{2}$ | 344 | 4·9 | 299 | 1331 |
| 1 | 206 | 1·9 | 189 | 1187 |
| $0\frac{1}{2}$ | 94 | 0·4 | 91 | 1081 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 8{\cdot}7$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 3° | 1401 | 50·4 | 809 | 3399 |
| $2\frac{3}{4}$ | 1039 | 32·1 | 684 | 2473 |
| $2\frac{1}{2}$ | 820 | 22·0 | 586 | 2043 |
| $2\frac{1}{4}$ | 662 | 15·4 | 503 | 1780 |
| 2 | 538 | 10·8 | 430 | 1598 |
| $1\frac{3}{4}$ | 436 | 7·5 | 363 | 1462 |
| $1\frac{1}{2}$ | 349 | 5·0 | 301 | 1356 |
| 1 | 208 | 1·9 | 190 | 1199 |
| $0\frac{1}{2}$ | 95 | 0·4 | 91 | 1086 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 153 | 1·3 | 163 | 876 |
| 2 | 273 | 4·4 | 308 | 789 |
| 3 | 373 | 8·7 | 440 | 724 |
| 4 | 458 | 13·9 | 562 | 673 |
| 5 | 532 | 19·7 | 676 | 632 |
| 6 | 598 | 26·0 | 784 | 597 |

IX. (*continued*).

| $\lambda = 8{\cdot}7$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 7° | 657 | 32·8 | 886 | 568 |
| 8 | 711 | 39·9 | 984 | 543 |
| 9 | 760 | 47·3 | 1078 | 522 |
| 10 | 806 | 54·9 | 1169 | 502 |
| 11 | 848 | 62·8 | 1256 | 486 |
| 12 | 888 | 70·9 | 1342 | 470 |
| 13 | 926 | 79·2 | 1424 | 456 |
| 14 | 961 | 87·7 | 1505 | 444 |
| 15 | 995 | 96·4 | 1584 | 433 |
| 16 | 1027 | 105·2 | 1662 | 423 |
| 17 | 1057 | 114·3 | 1738 | 413 |
| 18 | 1086 | 123·5 | 1813 | 405 |
| 19 | 1114 | 132·8 | 1887 | 397 |
| 20 | 1141 | 142·4 | 1959 | 389 |
| 21 | 1167 | 152·1 | 2031 | 383 |
| 22 | 1193 | 162·0 | 2102 | 376 |
| 23 | 1217 | 172·1 | 2173 | 370 |
| 24 | 1240 | 182·3 | 2243 | 365 |

| $\lambda = 9{\cdot}1$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $2\frac{3}{4}$° | 1141 | 36·3 | 710 | 2827 |
| $2\frac{1}{2}$ | 870 | 23·8 | 601 | 2210 |
| $2\frac{1}{4}$ | 690 | 16·3 | 513 | 1876 |
| 2 | 555 | 11·3 | 436 | 1658 |
| $1\frac{3}{4}$ | 446 | 7·7 | 367 | 1502 |
| $1\frac{1}{2}$ | 356 | 5·2 | 304 | 1383 |
| 1 | 210 | 2·0 | 191 | 1211 |
| $0\frac{1}{2}$ | 95 | 0·4 | 91 | 1090 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 9{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $2\frac{3}{4}$° | 1287 | 42·5 | 742 | 3394 |
| $2\frac{1}{2}$ | 932 | 26·1 | 618 | 2426 |
| $2\frac{1}{4}$ | 723 | 17·3 | 523 | 1989 |
| 2 | 573 | 11·8 | 442 | 1725 |
| $1\frac{3}{4}$ | 457 | 8·0 | 371 | 1545 |
| $1\frac{1}{2}$ | 362 | 5·3 | 307 | 1411 |
| 1 | 212 | 2·0 | 192 | 1223 |
| $0\frac{1}{2}$ | 95 | 0·4 | 91 | 1095 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 151 | 1·3 | 162 | 867 |
| 2 | 268 | 4·3 | 305 | 776 |
| 3 | 364 | 8·4 | 434 | 708 |
| 4 | 445 | 13·4 | 554 | 657 |
| 5 | 515 | 18·9 | 665 | 615 |
| 6 | 578 | 24·9 | 770 | 580 |
| 7 | 633 | 31·3 | 869 | 551 |
| 8 | 684 | 37·9 | 964 | 527 |
| 9 | 731 | 44·8 | 1055 | 505 |
| 10 | 773 | 52·0 | 1142 | 486 |
| 11 | 813 | 59·4 | 1227 | 469 |
| 12 | 850 | 66·9 | 1309 | 454 |
| 13 | 885 | 74·7 | 1389 | 441 |
| 14 | 918 | 82·6 | 1467 | 428 |
| 15 | 949 | 90·6 | 1544 | 418 |
| 16 | 979 | 98·9 | 1618 | 407 |
| 17 | 1007 | 107·3 | 1692 | 398 |
| 18 | 1034 | 115·8 | 1764 | 390 |
| 19 | 1060 | 124·5 | 1835 | 382 |
| 20 | 1085 | 133·3 | 1905 | 375 |
| 21 | 1109 | 142·3 | 1974 | 368 |
| 22 | 1133 | 151·5 | 2042 | 362 |
| 23 | 1155 | 160·8 | 2110 | 356 |
| 24 | 1177 | 170·3 | 2177 | 351 |

IX. (*continued*).

| $\lambda = 9{\cdot}9$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $2\frac{1}{2}^\circ$ | 1011 | 29·0 | 639 | 2722 |
| $2\frac{1}{4}$ | 761 | 18·6 | 534 | 2125 |
| 2 | 594 | 12·4 | 449 | 1802 |
| $1\frac{3}{4}$ | 469 | 8·3 | 375 | 1592 |
| $1\frac{1}{2}$ | 369 | 5·4 | 309 | 1442 |
| $1\frac{1}{4}$ | 286 | 3·4 | 249 | 1327 |
| 1 | 214 | 2·0 | 193 | 1236 |
| $0\frac{3}{4}$ | 152 | 1·0 | 141 | 1162 |
| $0\frac{1}{2}$ | 96 | 0·4 | 91 | 1100 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 10{\cdot}3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| $2\frac{1}{2}^\circ$ | 1118 | 33·1 | 663 | 3161 |
| $2\frac{1}{4}$ | 805 | 20·0 | 547 | 2293 |
| 2 | 617 | 13·0 | 457 | 1889 |
| $1\frac{3}{4}$ | 482 | 8·6 | 380 | 1644 |
| $1\frac{1}{2}$ | 376 | 5·6 | 312 | 1474 |
| $1\frac{1}{4}$ | 290 | 3·5 | 251 | 1348 |
| 1 | 216 | 2·0 | 194 | 1250 |
| $0\frac{3}{4}$ | 153 | 1·1 | 141 | 1170 |
| $0\frac{1}{2}$ | 96 | 0·4 | 92 | 1104 |
| 0 | 0 | 0 | 0 | 1000 |

| $\lambda = 10{\cdot}3$ | | | | |
|---|---|---|---|---|
| $\phi$ | $(x)$ | $(y)$ | $(t)$ | $(v)$ |
| 1° | 149 | 1·2 | 161 | 857 |
| 2 | 263 | 4·2 | 302 | 763 |
| 3 | 355 | 8·2 | 429 | 694 |
| 4 | 433 | 12·9 | 546 | 642 |
| 5 | 500 | 18·2 | 654 | 599 |
| 6 | 559 | 23·9 | 756 | 565 |
| 7 | 612 | 29·9 | 853 | 536 |
| 8 | 660 | 36·1 | 945 | 511 |
| 9 | 703 | 42·7 | 1033 | 490 |
| 10 | 744 | 49·4 | 1118 | 471 |
| 11 | 781 | 56·3 | 1200 | 454 |
| 12 | 816 | 63·4 | 1280 | 440 |
| 13 | 849 | 70·6 | 1357 | 426 |
| 14 | 879 | 78·0 | 1432 | 414 |
| 15 | 909 | 85·6 | 1506 | 403 |
| 16 | 936 | 93·3 | 1578 | 394 |
| 17 | 963 | 101·1 | 1649 | 385 |
| 18 | 988 | 109·0 | 1719 | 376 |
| 19 | 1012 | 117·1 | 1787 | 369 |
| 20 | 1035 | 125·4 | 1855 | 362 |
| 21 | 1058 | 133·8 | 1922 | 355 |
| 22 | 1079 | 142·3 | 1988 | 349 |
| 23 | 1100 | 150·9 | 2053 | 344 |
| 24 | 1121 | 159·8 | 2118 | 338 |

## X.

$\{1000 \div v\}^2$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | — |
| 10 | 100·00 | 98·03 | 96·12 | 94·26 | 92·46 | 90·70 | 89·00 | 87·34 | 85·73 | 84·17 | 1·76 |
| 11 | 82·64 | 81·16 | 79·72 | 78·31 | 76·95 | 75·61 | 74·32 | 73·05 | 71·82 | 70·62 | 1·33 |
| 12 | 69·44 | 68·30 | 67·19 | 66·10 | 65·04 | 64·00 | 62·99 | 62·00 | 61·04 | 60·09 | 1·04 |
| 13 | 59·17 | 58·27 | 57·39 | 56·53 | 55·69 | 54·87 | 54·07 | 53·28 | 52·51 | 51·76 | ·83 |
| 14 | 51·02 | 50·30 | 49·59 | 48·90 | 48·23 | 47·56 | 46·91 | 46·28 | 45·65 | 45·04 | 66 |
| 15 | 44·44 | 43·86 | 43·28 | 42·72 | 42·17 | 41·62 | 41·09 | 40·57 | 40·06 | 39·56 | 54 |
| 16 | 39·06 | 38·58 | 38·10 | 37·64 | 37·18 | 36·73 | 36·29 | 35·86 | 35·43 | 35·01 | 45 |
| 17 | 34·60 | 34·20 | 33·80 | 33·41 | 33·03 | 32·65 | 32·28 | 31·92 | 31·56 | 31·21 | 38 |
| 18 | 30·86 | 30·52 | 30·19 | 29·86 | 29·54 | 29·22 | 28·91 | 28·60 | 28·29 | 28·00 | 32 |
| 19 | 27·70 | 27·41 | 27·13 | 26·85 | 26·57 | 26·30 | 26·03 | 25·77 | 25·51 | 25·25 | 27 |
| 20 | 25·00 | 24·75 | 24·51 | 24·27 | 24·03 | 23·80 | 23·57 | 23·34 | 23·11 | 22·89 | 23 |
| 21 | 22·68 | 22·46 | 22·25 | 22·04 | 21·84 | 21·63 | 21·43 | 21·24 | 21·04 | 20·85 | 20 |
| 22 | 20·66 | 20·48 | 20·29 | 20·11 | 19·93 | 19·75 | 19·58 | 19·41 | 19·24 | 19·07 | 18 |
| 23 | 18·90 | 18·74 | 18·58 | 18·42 | 18·26 | 18·11 | 17·96 | 17·80 | 17·65 | 17·51 | 15 |
| 24 | 17·36 | 17·22 | 17·08 | 16·94 | 16·80 | 16·66 | 16·53 | 16·39 | 16·26 | 16·13 | 14 |
| 25 | 16·00 | 15·87 | 15·75 | 15·62 | 15·50 | 15·38 | 15·26 | 15·14 | 15·02 | 14·91 | 12 |
| 26 | 14·79 | 14·68 | 14·57 | 14·46 | 14·35 | 14·24 | 14·13 | 14·03 | 13·92 | 13·82 | 11 |
| 27 | 13·72 | 13·62 | 13·52 | 13·42 | 13·32 | 13·22 | 13·13 | 13·03 | 12·94 | 12·85 | 10 |
| 28 | 12·755 | 2·664 | 2·575 | 2·486 | 2·398 | 2·311 | 2·226 | 2·140 | 2·056 | 1·973 | 87 |
| 29 | 1·891 | 1·809 | 1·728 | 1·648 | 1·569 | 1·491 | 1·413 | 1·337 | 1·261 | 1·186 | 78 |
| 30 | 1·111 | 1·037 | 0·964 | 0·892 | 0·821 | 0·750 | 0·680 | 0·610 | 0·541 | 0·473 | 71 |
| 31 | 10·406 | 0·339 | 0·273 | 0·207 | 0·142 | 0·078 | 0·014 | *9·951 | *9·889 | *9·827 | 64 |
| 32 | 9·766 | 9·705 | 9·645 | 9·585 | 9·526 | 9·467 | 9·409 | 9·352 | 9·295 | 9·239 | 59 |
| 33 | 9·183 | 9·127 | 9·072 | 9·018 | 8·964 | 8·911 | 8·858 | 8·805 | 8·753 | 8·702 | 53 |
| 34 | 8·651 | 8·600 | 8·550 | 8·500 | 8·451 | 8·402 | 8·353 | 8·305 | 8·257 | 8·210 | 49 |
| 35 | 8·163 | 8·117 | 8·071 | 8·025 | 7·980 | 7·935 | 7·890 | 7·846 | 7·803 | 7·759 | 45 |
| 36 | 7·716 | 7·673 | 7·631 | 7·589 | 7·547 | 7·506 | 7·465 | 7·425 | 7·384 | 7·344 | 41 |
| 37 | 7·305 | 7·265 | 7·226 | 7·188 | 7·149 | 7·111 | 7·073 | 7·036 | 6·999 | 6·962 | 38 |
| 38 | 6·925 | 6·889 | 6·853 | 6·817 | 6·782 | 6·746 | 6·711 | 6·677 | 6·643 | 6·608 | 35 |
| 39 | 6·575 | 6·541 | 6·508 | 6·475 | 6·442 | 6·409 | 6·377 | 6·345 | 6·313 | 6·281 | 33 |
| 40 | 6·250 | 6·219 | 6·188 | 6·157 | 6·127 | 6·097 | 6·067 | 6·037 | 6·007 | 5·978 | 30 |
| 41 | 5·949 | 5·920 | 5·891 | 5·863 | 5·834 | 5·806 | 5·778 | 5·751 | 5·723 | 5·696 | 28 |
| 42 | 5·669 | 5·642 | 5·615 | 5·589 | 5·562 | 5·536 | 5·510 | 5·485 | 5·459 | 5·434 | 26 |
| 43 | 5·408 | 5·383 | 5·358 | 5·334 | 5·309 | 5·285 | 5·260 | 5·236 | 5·213 | 5·189 | 24 |
| 44 | 5·165 | 5·142 | 5·119 | 5·096 | 5·073 | 5·050 | 5·027 | 5·005 | 4·982 | 4·960 | 23 |
| 45 | 4·938 | 4·916 | 4·895 | 4·873 | 4·852 | 4·830 | 4·809 | 4·788 | 4·767 | 4·747 | 21 |
| 46 | 4·726 | 4·705 | 4·685 | 4·665 | 4·645 | 4·625 | 4·605 | 4·585 | 4·566 | 4·546 | 20 |
| 47 | 4·527 | 4·508 | 4·489 | 4·470 | 4·451 | 4·432 | 4·414 | 4·395 | 4·377 | 4·358 | 19 |
| 48 | 4·340 | 4·322 | 4·304 | 4·287 | 4·269 | 4·251 | 4·234 | 4·216 | 4·199 | 4·182 | 18 |

## X. (*continued*).

$\{1000 \div v\}^2$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 49 | 4·165 | 4·148 | 4·131 | 4·114 | 4·098 | 4·081 | 4·065 | 4·048 | 4·032 | 4·016 | 17 |
| 50 | 4·000 | 3·984 | 3·968 | 3·952 | 3·937 | 3·921 | 3·906 | 3·890 | 3·875 | 3·860 | 16 |
| 51 | 3·845 | 3·830 | 3·815 | 3·800 | 3·785 | 3·770 | 3·756 | 3·741 | 3·727 | 3·713 | 15 |
| 52 | 3·698 | 3·684 | 3·670 | 3·656 | 3·642 | 3·628 | 3·614 | 3·601 | 3·587 | 3·574 | 14 |
| 53 | 3·560 | 3·547 | 3·533 | 3·520 | 3·507 | 3·494 | 3·481 | 3·468 | 3·455 | 3·442 | 13 |
| 54 | 3·429 | 3·417 | 3·404 | 3·392 | 3·379 | 3·367 | 3·354 | 3·342 | 3·330 | 3·319 | 12 |
| 55 | 3·3058 | ·2938 | ·2819 | ·2700 | ·2582 | ·2464 | ·2348 | ·2232 | ·2117 | ·2001 | 117 |
| 56 | ·1888 | ·1774 | ·1662 | ·1549 | ·1437 | ·1325 | ·1215 | ·1105 | ·0996 | ·0887 | 111 |
| 57 | ·0779 | ·0671 | ·0564 | ·0457 | ·0351 | ·0245 | ·0140 | ·0036 | *·9933 | *·9829 | 106 |
| 58 | 2·9727 | ·9624 | ·9523 | ·9421 | ·9320 | ·6220 | ·9121 | ·9022 | ·8923 | ·8825 | 100 |
| 59 | ·8727 | ·8630 | ·8534 | ·8437 | ·8341 | ·8246 | ·8152 | ·8058 | ·7964 | ·7871 | 95 |
| 60 | ·7778 | ·7685 | ·7594 | ·7502 | ·7411 | ·7320 | ·7230 | ·7141 | ·7052 | ·6963 | 91 |
| 61 | 2·6875 | ·6787 | ·6699 | ·6612 | ·6525 | ·6439 | ·6353 | ·6268 | ·6183 | ·6099 | 86 |
| 62 | ·6015 | ·5931 | ·5848 | ·5765 | ·5682 | ·5600 | ·5518 | ·5437 | ·5356 | ·5276 | 82 |
| 63 | ·5195 | ·5116 | ·5036 | ·4957 | ·4878 | ·4800 | ·4722 | ·4645 | ·4568 | ·4491 | 78 |
| 64 | 2·4414 | ·4338 | ·4262 | ·4187 | ·4111 | ·4037 | ·3962 | ·3889 | ·3815 | ·3742 | 75 |
| 65 | ·3669 | ·3596 | ·3524 | ·3452 | ·3380 | ·3308 | ·3237 | ·3167 | ·3097 | ·3027 | 71 |
| 66 | ·2957 | ·2887 | ·2818 | ·2750 | ·2681 | ·2613 | ·2545 | ·2477 | ·2410 | ·2343 | 67 |
| 67 | 2·2277 | ·2210 | ·2144 | ·2078 | ·2013 | ·1948 | ·1883 | ·1818 | ·1754 | ·1690 | 65 |
| 68 | ·1626 | ·1562 | ·1500 | ·1437 | ·1374 | ·1312 | ·1249 | ·1188 | ·1126 | ·1065 | 62 |
| 69 | ·1004 | ·0943 | ·0883 | ·0822 | ·0762 | ·0703 | ·0643 | ·0584 | ·0525 | ·0467 | 60 |
| 70 | 2·0408 | ·0350 | ·0292 | ·0234 | ·0177 | ·0120 | ·0063 | ·0006 | *·9950 | *·9893 | 57 |
| 71 | 1·9837 | ·9782 | ·9726 | ·9671 | ·9616 | ·9561 | ·9506 | ·9452 | ·9398 | ·9344 | 55 |
| 72 | ·9290 | ·9237 | ·9184 | ·9130 | ·9077 | ·9025 | ·8972 | ·8920 | ·8869 | ·8817 | 53 |
| 73 | 1·8765 | ·8714 | ·8663 | ·8612 | ·8561 | ·8511 | ·8460 | ·8410 | ·8361 | ·8311 | 50 |
| 74 | ·8262 | ·8212 | ·8163 | ·8114 | ·8066 | ·8017 | ·7969 | ·7921 | ·7873 | ·7825 | 49 |
| 75 | ·7778 | ·7730 | ·7683 | ·7636 | ·7590 | ·7543 | ·7497 | ·7450 | ·7405 | ·7359 | 47 |
| 76 | 1·7313 | ·7268 | ·7224 | ·7177 | ·7132 | ·7087 | ·7043 | ·6998 | ·6954 | ·6910 | 45 |
| 77 | ·6866 | ·6823 | ·6779 | ·6736 | ·6692 | ·6649 | ·6606 | ·6564 | ·6521 | ·6479 | 43 |
| 78 | ·6437 | ·6395 | ·6353 | ·6311 | ·6269 | ·6228 | ·6186 | ·6145 | ·6105 | ·6064 | 42 |
| 79 | 1·6023 | ·5983 | ·5942 | ·5902 | ·5862 | ·5822 | ·5782 | ·5743 | ·5704 | ·5664 | 40 |
| 80 | ·5625 | ·5586 | ·5547 | ·5508 | ·5470 | ·5431 | ·5393 | ·5355 | ·5317 | ·5279 | 38 |
| 81 | ·5242 | ·5204 | ·5167 | ·5129 | ·5092 | ·5055 | ·5018 | ·4982 | ·4945 | ·4908 | 37 |
| 82 | 1·4872 | ·4836 | ·4800 | ·4764 | ·4728 | ·4692 | ·4657 | ·4621 | ·4586 | ·4551 | 36 |
| 83 | ·4516 | ·4481 | ·4446 | ·4412 | ·4377 | ·4342 | ·4308 | ·4274 | ·4238 | ·4206 | 34 |
| 84 | ·4172 | ·4139 | ·4105 | ·4072 | ·4038 | ·4005 | ·3972 | ·3939 | ·3906 | ·3873 | 33 |
| 85 | 1·3841 | ·3808 | ·3776 | ·3744 | ·3711 | ·3679 | ·3647 | ·3616 | ·3584 | ·3552 | 32 |
| 86 | ·3521 | ·3489 | ·3458 | ·3427 | ·3396 | ·3365 | ·3334 | ·3303 | ·3273 | ·3242 | 31 |
| 87 | ·3212 | ·3181 | ·3151 | ·3121 | ·3091 | ·3061 | ·3031 | ·3002 | ·2972 | ·2943 | 30 |

## X. (*continued*).

$\{1000 \div v\}^2$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 88 | 1·2913 | ·2884 | ·2855 | ·2826 | ·2797 | ·2768 | ·2739 | ·2710 | ·2682 | ·2653 | 29 |
| 89 | ·2625 | ·2596 | ·2568 | ·2540 | ·2512 | ·2484 | ·2456 | ·2428 | ·2401 | ·2373 | 28 |
| 90 | ·2346 | ·2318 | ·2291 | ·2264 | ·2237 | ·2210 | ·2183 | ·2156 | ·2129 | ·2102 | 27 |
| 91 | 1·2076 | ·2049 | ·2023 | ·1997 | ·1970 | ·1944 | ·1918 | ·1892 | ·1866 | ·1840 | 26 |
| 92 | ·1815 | ·1789 | ·1764 | ·1738 | ·1713 | ·1687 | ·1662 | ·1637 | ·1612 | ·1587 | 25 |
| 93 | ·1562 | ·1537 | ·1513 | ·1488 | ·1463 | ·1439 | ·1414 | ·1390 | ·1366 | ·1341 | 25 |
| 94 | 1·1317 | ·1293 | ·1269 | ·1245 | ·1222 | ·1198 | ·1174 | ·1151 | ·1127 | ·1104 | 24 |
| 95 | ·1080 | ·1057 | ·1034 | ·1011 | ·0988 | ·0965 | ·0942 | ·0919 | ·0896 | ·0873 | 23 |
| 96 | ·0851 | ·0828 | ·0806 | ·0783 | ·0761 | ·0738 | ·0716 | ·0694 | ·0672 | ·0650 | 22 |
| 97 | 1·0628 | ·0606 | ·0584 | ·0563 | ·0541 | ·0519 | ·0498 | ·0476 | ·0455 | ·0434 | 22 |
| 98 | ·0412 | ·0391 | ·0370 | ·0349 | ·0328 | ·0307 | ·0286 | ·0265 | ·0244 | ·0224 | 21 |
| 99 | ·0203 | ·0182 | ·0161 | ·0141 | ·0121 | ·0101 | ·0080 | ·c060 | ·0040 | ·0020 | 20 |
| 100 | 1·0000 | *·9980 | *·9960 | *·9940 | *·9920 | *·9901 | *·9881 | *·9861 | *·9842 | *·9822 | 20 |
| 101 | 0·9803 | ·9783 | ·9764 | ·9745 | ·9725 | ·9707 | ·9688 | ·9668 | ·9649 | ·9631 | 19 |
| 102 | ·9612 | ·9593 | ·9574 | ·9555 | ·9537 | ·9518 | ·9500 | ·9481 | ·9463 | ·9444 | 19 |
| 103 | 0·9426 | ·9408 | ·9389 | ·9371 | ·9353 | ·9335 | ·9317 | ·9299 | ·9281 | ·9263 | 18 |
| 104 | ·9246 | ·9228 | ·9210 | ·9192 | ·9175 | ·9157 | ·9140 | ·9124 | ·9105 | ·9088 | 18 |
| 105 | ·9070 | ·9053 | ·9036 | ·9019 | ·9002 | ·8985 | ·8968 | ·8951 | ·8934 | ·8917 | 17 |
| 106 | 0 8900 | ·8883 | ·8866 | ·8850 | ·8833 | ·8817 | ·8800 | ·8784 | ·8767 | ·8751 | 17 |
| 107 | ·8734 | ·8718 | ·8702 | ·8686 | ·8669 | ·8653 | ·8637 | ·8621 | ·8605 | ·8589 | 16 |
| 108 | ·8573 | ·8558 | ·8542 | ·8526 | ·8510 | ·8495 | ·8479 | ·8463 | ·8448 | ·8432 | 16 |
| 109 | 0·8417 | ·8401 | ·8386 | ·8371 | ·8355 | ·8340 | ·8325 | ·8310 | ·8295 | ·8280 | 15 |
| 110 | ·8264 | ·8249 | ·8234 | ·8220 | ·8205 | ·8190 | ·8175 | ·8160 | ·8146 | ·8131 | 15 |
| 111 | ·8116 | ·8102 | ·8087 | ·8073 | ·8058 | ·8044 | ·8029 | ·8015 | ·8000 | ·7986 | 14 |
| 112 | 0·7972 | ·7958 | ·7944 | ·7929 | ·7915 | ·7901 | ·7887 | ·7873 | ·7859 | ·7845 | 14 |
| 113 | ·7831 | ·7818 | ·7804 | ·7790 | ·7776 | ·7763 | ·7749 | ·7735 | ·7722 | ·7708 | 14 |
| 114 | ·7695 | ·7681 | ·7668 | ·7654 | ·7641 | ·7628 | ·7614 | ·7601 | ·7588 | ·7575 | 13 |
| 115 | 0·7561 | ·7548 | ·7535 | ·7522 | ·7509 | ·7496 | ·7483 | ·7470 | ·7457 | ·7444 | 13 |
| 116 | ·7432 | ·7419 | ·7406 | ·7393 | ·7381 | ·7368 | ·7355 | ·7343 | ·7330 | ·7318 | 13 |
| 117 | ·7305 | ·7293 | ·7280 | ·7268 | ·7255 | ·7243 | ·7231 | ·7219 | ·7206 | ·7194 | 12 |
| 118 | 0·7182 | ·7170 | ·7158 | ·7145 | ·7133 | ·7121 | ·7109 | ·7097 | ·7085 | ·7074 | 12 |
| 119 | ·7062 | ·7050 | ·7038 | ·7026 | ·7014 | ·7003 | ·6991 | ·6979 | ·6968 | ·6956 | 12 |
| 120 | ·6944 | ·6933 | ·6921 | ·6910 | ·6898 | ·6887 | ·6876 | ·6864 | ·6853 | ·6841 | 12 |
| 121 | 0·6830 | ·6819 | ·6808 | ·6796 | ·6785 | ·6774 | ·6763 | ·6752 | ·6741 | ·6730 | 11 |
| 122 | ·6719 | ·6708 | ·6697 | ·6686 | ·6675 | ·6664 | ·6653 | ·6642 | ·6631 | ·6621 | 11 |
| 123 | ·6610 | ·6599 | ·6588 | ·6578 | ·6567 | ·6556 | ·6546 | ·6535 | ·6525 | ·6514 | 11 |
| 124 | 0·6504 | ·6493 | ·6483 | ·6472 | ·6462 | ·6452 | ·6441 | ·6431 | ·6421 | ·6410 | 10 |
| 125 | ·6400 | ·6390 | ·6380 | ·6369 | ·6359 | ·6349 | ·6339 | ·6329 | ·6319 | ·6309 | 10 |
| 126 | ·6299 | ·6289 | ·6279 | ·6269 | ·6259 | ·6249 | ·6239 | ·6229 | ·6220 | ·6210 | 10 |

## X. (*continued*).

$\{1000 \div v\}^2$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 127 | 0·6200 | ·6190 | ·6181 | ·6171 | ·6161 | ·6151 | ·6142 | ·6132 | ·6123 | ·6113 | 10 |
| 128 | ·6104 | ·6094 | ·6084 | ·6075 | ·6066 | ·6056 | ·6047 | ·6037 | ·6028 | ·6019 | 9 |
| 129 | ·6009 | ·6000 | ·5991 | ·5981 | ·5972 | ·5963 | ·5954 | ·5945 | ·5935 | ·5926 | 9 |
| 130 | 0·5917 | ·5908 | ·5899 | ·5890 | ·5881 | ·5872 | ·5863 | ·5854 | ·5845 | ·5836 | 9 |
| 131 | ·5827 | ·5818 | ·5809 | ·5801 | ·5792 | ·5783 | ·5774 | ·5765 | ·5757 | ·5748 | 9 |
| 132 | ·5739 | ·5731 | ·5722 | ·5713 | ·5705 | ·5696 | ·5687 | ·5679 | ·5670 | ·5662 | 9 |
| 133 | 0·5653 | ·5645 | ·5636 | ·5628 | ·5619 | ·5611 | ·5603 | ·5594 | ·5586 | ·5577 | 8 |
| 134 | ·5569 | ·5561 | ·5553 | ·5544 | ·5536 | ·5528 | ·5520 | ·5511 | ·5503 | ·5495 | 8 |
| 135 | ·5487 | ·5479 | ·5471 | ·5463 | ·5455 | ·5447 | ·5439 | ·5431 | ·5423 | ·5415 | 8 |
| 136 | 0·5 4066 | 3986 | 3907 | 3828 | 3749 | 3670 | 3592 | 3513 | 3435 | 3357 | 79 |
| 137 | 3279 | 3202 | 3124 | 3047 | 2970 | 2893 | 2816 | 2739 | 2663 | 2586 | 77 |
| 138 | 2510 | 2434 | 2359 | 2282 | 2207 | 2132 | 2056 | 1981 | 1906 | 1832 | 75 |
| 139 | 0·5 1757 | 1683 | 1608 | 1534 | 1461 | 1387 | 1313 | 1240 | 1166 | 1093 | 74 |
| 140 | 1020 | 0947 | 0875 | 0802 | 0730 | 0658 | 0586 | 0514 | 0442 | 0370 | 72 |
| 141 | 0299 | 0228 | 0157 | 0086 | 0015 | *9944 | *9874 | *9804 | *9733 | *9663 | 71 |
| 142 | 0·4 9593 | 9524 | 9454 | 9384 | 9314 | 9246 | 9177 | 9108 | 9039 | 8971 | 70 |
| 143 | 8902 | 8834 | 8766 | 8698 | 8631 | 8562 | 8494 | 8427 | 8360 | 8292 | 68 |
| 144 | 8225 | 8158 | 8092 | 8025 | 7959 | 7892 | 7826 | 7760 | 7694 | 7628 | 66 |
| 145 | 0·4 7562 | 7497 | 7432 | 7366 | 7301 | 7236 | 7171 | 7106 | 7042 | 6977 | 65 |
| 146 | 6913 | 6849 | 6785 | 6721 | 6657 | 6593 | 6530 | 6466 | 6403 | 6340 | 64 |
| 147 | 6277 | 6215 | 6152 | 6089 | 6026 | 5964 | 5901 | 5839 | 5777 | 5716 | 62 |
| 148 | 0·4 5652 | 5592 | 5531 | 5469 | 5408 | 5347 | 5286 | 5225 | 5164 | 5104 | 61 |
| 149 | 5043 | 4983 | 4922 | 4862 | 4802 | 4742 | 4682 | 4623 | 4563 | 4504 | 60 |
| 150 | 4444 | 4385 | 4326 | 4267 | 4208 | 4150 | 4091 | 4033 | 3974 | 3916 | 59 |
| 151 | 0·4 3858 | 3800 | 3742 | 3684 | 3626 | 3569 | 3511 | 3454 | 3397 | 3340 | 58 |
| 152 | 3283 | 3226 | 3169 | 3112 | 3055 | 2999 | 2943 | 2887 | 2831 | 2775 | 56 |
| 153 | 2719 | 2663 | 2607 | 2552 | 2496 | 2441 | 2385 | 2330 | 2275 | 2220 | 55 |
| 154 | 0·4 2166 | 2111 | 2056 | 2002 | 1947 | 1893 | 1839 | 1785 | 1731 | 1677 | 54 |
| 155 | 1623 | 1570 | 1516 | 1463 | 1409 | 1356 | 1303 | 1250 | 1197 | 1144 | 53 |
| 156 | 1091 | 1039 | 0986 | 0934 | 0881 | 0829 | 0777 | 0725 | 0673 | 0621 | 52 |
| 157 | 0·4 0570 | 0518 | 0466 | 0415 | 0364 | 0312 | 0261 | 0210 | 0159 | 0109 | 51 |
| 158 | 0058 | 0007 | *9956 | *9906 | *9856 | *9805 | *9755 | *9705 | *9655 | *9605 | 50 |
| 159 | 0·3 9555 | 9506 | 9456 | 9407 | 9357 | 9308 | 9259 | 9209 | 9160 | 9111 | 49 |
| 160 | 0·3 9063 | 9014 | 8965 | 8916 | 8868 | 8820 | 8771 | 8723 | 8675 | 8627 | 48 |
| 161 | 8579 | 8531 | 8483 | 8435 | 8388 | 8340 | 8293 | 8245 | 8198 | 8151 | 48 |
| 162 | 8104 | 8057 | 8010 | 7963 | 7916 | 7870 | 7823 | 7777 | 7730 | 7684 | 47 |
| 163 | 0·3 7638 | 7592 | 7546 | 7500 | 7454 | 7408 | 7362 | 7317 | 7271 | 7226 | 46 |
| 164 | 7180 | 7135 | 7090 | 7045 | 7000 | 6955 | 6910 | 6865 | 6820 | 6776 | 45 |
| 165 | 6731 | 6686 | 6642 | 6598 | 6554 | 6509 | 6465 | 6421 | 6377 | 6334 | 44 |

X. (*continued*).

$\{1000 \div v\}^2$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | — |
| 166 | 0·3 6290 | 6246 | 6202 | 6159 | 6115 | 6072 | 6029 | 5986 | 5942 | 5899 | 43 |
| 167 | 5856 | 5813 | 5771 | 5728 | 5685 | 5643 | 5600 | 5558 | 5515 | 5473 | 43 |
| 168 | 5431 | 5389 | 5347 | 5305 | 5263 | 5221 | 5179 | 5137 | 5096 | 5054 | 42 |
| 169 | 0·3 5013 | 4971 | 4930 | 4889 | 4848 | 4807 | 4766 | 4725 | 4684 | 4643 | 41 |
| 170 | 4602 | 4561 | 4521 | 4480 | 4440 | 4399 | 4359 | 4319 | 4279 | 4239 | 40 |
| 171 | 4199 | 4159 | 4119 | 4079 | 4039 | 3999 | 3960 | 3920 | 3881 | 3841 | 40 |
| 172 | 0·3 3802 | 3763 | 3724 | 3684 | 3645 | 3606 | 3567 | 3529 | 3490 | 3451 | 39 |
| 173 | 3412 | 3374 | 3335 | 3297 | 3258 | 3220 | 3182 | 3144 | 3106 | 3067 | 38 |
| 174 | 3029 | 2992 | 2954 | 2916 | 2878 | 2840 | 2803 | 2765 | 2728 | 2690 | 38 |
| 175 | 0·3 2653 | 2616 | 2579 | 2541 | 2504 | 2467 | 2430 | 2394 | 2357 | 2320 | 37 |
| 176 | 2283 | 2246 | 2210 | 2173 | 2137 | 2100 | 2064 | 2028 | 1991 | 1955 | 36 |
| 177 | 1919 | 1883 | 1847 | 1811 | 1776 | 1740 | 1704 | 1668 | 1633 | 1597 | 36 |
| 178 | 0·3 1562 | 1526 | 1491 | 1456 | 1421 | 1385 | 1350 | 1315 | 1280 | 1245 | 35 |
| 179 | 1210 | 1175 | 1140 | 1106 | 1071 | 1036 | 1002 | 0967 | 0933 | 0899 | 34 |
| 180 | 0864 | 0830 | 0796 | 0762 | 0727 | 0693 | 0659 | 0626 | 0592 | 0558 | 34 |
| 181 | 0·3 0524 | 0490 | 0457 | 0423 | 0390 | 0356 | 0323 | 0289 | 0256 | 0223 | 33 |
| 182 | 0190 | 0156 | 0123 | 0090 | 0057 | 0024 | *9992 | *9959 | *9926 | *9893 | 33 |
| 183 | 0·2 9861 | 9828 | 9795 | 9763 | 9730 | 9698 | 9666 | 9633 | 9601 | 9569 | 32 |
| 184 | 0·2 9538 | 9505 | 9473 | 9441 | 9409 | 9377 | 9345 | 9313 | 9282 | 9250 | 32 |
| 185 | 9218 | 9187 | 9155 | 9124 | 9092 | 9061 | 9030 | 8999 | 8967 | 8936 | 31 |
| 186 | 8905 | 8874 | 8843 | 8812 | 8781 | 8750 | 8719 | 8689 | 8658 | 8627 | 31 |
| 187 | 0·2 8597 | 8566 | 8536 | 8505 | 8475 | 8444 | 8414 | 8384 | 8354 | 8323 | 30 |
| 188 | 8293 | 8263 | 8233 | 8203 | 8173 | 8143 | 8114 | 8084 | 8054 | 8024 | 30 |
| 189 | 7995 | 7965 | 7936 | 7906 | 7877 | 7847 | 7818 | 7789 | 7759 | 7730 | 29 |
| 190 | 0·2 7700 | 7672 | 7643 | 7614 | 7585 | 7556 | 7527 | 7498 | 7469 | 7440 | 29 |
| 191 | 7412 | 7383 | 7354 | 7326 | 7297 | 7269 | 7240 | 7212 | 7183 | 7155 | 29 |
| 192 | 7127 | 7099 | 7070 | 7042 | 7014 | 6986 | 6958 | 6930 | 6902 | 6874 | 28 |
| 193 | 0·2 6846 | 6819 | 6791 | 6763 | 6735 | 6708 | 6680 | 6653 | 6625 | 6598 | 28 |
| 194 | 6570 | 6543 | 6516 | 6488 | 6461 | 6434 | 6407 | 6380 | 6353 | 6325 | 27 |
| 195 | 6298 | 6272 | 6245 | 6218 | 6191 | 6164 | 6137 | 6111 | 6084 | 6057 | 27 |
| 196 | 0·2 6031 | 6004 | 5978 | 5951 | 5925 | 5899 | 5872 | 5846 | 5820 | 5793 | 26 |
| 197 | 5767 | 5741 | 5715 | 5689 | 5663 | 5637 | 5611 | 5585 | 5559 | 5533 | 26 |
| 198 | 5508 | 5482 | 5456 | 5430 | 5405 | 5379 | 5354 | 5328 | 5303 | 5277 | 26 |
| 199 | 0·2 5252 | 5227 | 5201 | 5176 | 5151 | 5125 | 5100 | 5075 | 5050 | 5025 | 25 |
| 200 | 5000 | 4975 | 4950 | 4925 | 4900 | 4875 | 4851 | 4826 | 4801 | 4777 | 25 |
| 201 | 4752 | 4727 | 4703 | 4678 | 4654 | 4629 | 4605 | 4580 | 4556 | 4532 | 24 |
| 202 | 0·2 4507 | 4483 | 4459 | 4435 | 4411 | 4387 | 4362 | 4338 | 4314 | 4290 | 24 |
| 203 | 4267 | 4243 | 4219 | 4195 | 4171 | 4147 | 4124 | 4100 | 4076 | 4053 | 24 |
| 204 | 4029 | 4006 | 3982 | 3959 | 3935 | 3912 | 3888 | 3865 | 3842 | 3819 | 23 |

## X. (*continued*).

$\{1000 \div v\}^2$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 205 | 0·2 3795 | 3772 | 3749 | 3726 | 3703 | 3680 | 3657 | 3634 | 3611 | 3588 | 23 |
| 206 | 3565 | 3542 | 3519 | 3496 | 3474 | 3451 | 3428 | 3406 | 3383 | 3360 | 23 |
| 207 | 3338 | 3315 | 3293 | 3270 | 3248 | 3225 | 3203 | 3181 | 3158 | 3136 | 22 |
| 208 | 0·2 3114 | 3092 | 3070 | 3047 | 3025 | 3003 | 2981 | 2959 | 2937 | 2915 | 22 |
| 209 | 2893 | 2871 | 2849 | 2827 | 2806 | 2784 | 2762 | 2741 | 2719 | 2697 | 22 |
| 210 | 2676 | 2654 | 2633 | 2611 | 2590 | 2568 | 2547 | 2525 | 2504 | 2483 | 21 |
| 211 | 0·2 2461 | 2440 | 2419 | 2398 | 2376 | 2355 | 2334 | 2313 | 2292 | 2271 | 21 |
| 212 | 2250 | 2229 | 2208 | 2187 | 2166 | 2145 | 2125 | 2104 | 2083 | 2062 | 21 |
| 213 | 2041 | 2021 | 2001 | 1980 | 1959 | 1938 | 1918 | 1897 | 1877 | 1856 | 21 |
| 214 | 0·2 1836 | 1816 | 1795 | 1775 | 1755 | 1734 | 1714 | 1694 | 1674 | 1653 | 20 |
| 215 | 1633 | 1613 | 1593 | 1573 | 1553 | 1533 | 1513 | 1493 | 1473 | 1453 | 20 |
| 216 | 1433 | 1414 | 1394 | 1374 | 1354 | 1335 | 1315 | 1295 | 1276 | 1256 | 20 |
| 217 | 0·2 1236 | 1217 | 1197 | 1178 | 1158 | 1139 | 1119 | 1100 | 1081 | 1061 | 19 |
| 218 | 1042 | 1023 | 1003 | 0984 | 0965 | 0946 | 0927 | 0908 | 0888 | 0869 | 19 |
| 219 | 0850 | 0831 | 0812 | 0793 | 0774 | 0755 | 0736 | 0718 | 0699 | 0680 | 19 |
| 220 | 0·2 0661 | 0642 | 0624 | 0605 | 0586 | 0568 | 0549 | 0530 | 0512 | 0493 | 19 |
| 221 | 0475 | 0456 | 0438 | 0419 | 0401 | 0382 | 0364 | 0346 | 0327 | 0309 | 18 |
| 222 | 0291 | 0272 | 0254 | 0236 | 0218 | 0199 | 0181 | 0163 | 0145 | 0127 | 18 |
| 223 | 0·2 0109 | 0091 | 0073 | 0055 | 0037 | 0019 | 0001 | *9983 | *9965 | *9948 | 18 |
| 224 | 0·1 9930 | 9912 | 9894 | 9877 | 9859 | 9841 | 9824 | 9806 | 9788 | 9771 | 18 |
| 225 | 9753 | 9736 | 9718 | 9701 | 9683 | 9666 | 9648 | 9631 | 9613 | 9596 | 17 |
| 226 | 0·1 9579 | 9561 | 9544 | 9527 | 9510 | 9492 | 9475 | 9458 | 9441 | 9424 | 17 |
| 227 | 9407 | 9389 | 9372 | 9355 | 9338 | 9321 | 9304 | 9287 | 9270 | 9254 | 17 |
| 228 | 9237 | 9220 | 9203 | 9186 | 9169 | 9153 | 9136 | 9119 | 9102 | 9086 | 17 |
| 229 | 0·1 9069 | 9052 | 9036 | 9019 | 9003 | 8986 | 8970 | 8953 | 8937 | 8920 | 17 |
| 230 | 8904 | 8887 | 8871 | 8854 | 8838 | 8822 | 8805 | 8789 | 8773 | 8757 | 16 |
| 231 | 8740 | 8724 | 8708 | 8692 | 8676 | 8659 | 8643 | 8627 | 8611 | 8595 | 16 |
| 232 | 0·1 8579 | 8563 | 8547 | 8531 | 8515 | 8499 | 8483 | 8467 | 8452 | 8436 | 16 |
| 233 | 8420 | 8404 | 8388 | 8373 | 8357 | 8341 | 8325 | 8310 | 8294 | 8278 | 16 |
| 234 | 8263 | 8247 | 8232 | 8216 | 8201 | 8185 | 8170 | 8154 | 8139 | 8123 | 16 |
| 235 | 0·1 8108 | 8092 | 8077 | 8062 | 8046 | 8031 | 8016 | 8000 | 7985 | 7970 | 15 |
| 236 | 7955 | 7939 | 7924 | 7909 | 7894 | 7879 | 7864 | 7849 | 7834 | 7818 | 15 |
| 237 | 7803 | 7788 | 7773 | 7758 | 7743 | 7729 | 7714 | 7699 | 7684 | 7669 | 15 |
| 238 | 0·1 7654 | 7639 | 7624 | 7610 | 7595 | 7580 | 7565 | 7551 | 7536 | 7521 | 15 |
| 239 | 7507 | 7492 | 7477 | 7463 | 7448 | 7434 | 7419 | 7405 | 7390 | 7376 | 15 |
| 240 | 7361 | 7347 | 7332 | 7318 | 7303 | 7289 | 7275 | 7260 | 7246 | 7232 | 14 |
| 241 | 0·1 7217 | 7203 | 7189 | 7175 | 7160 | 7146 | 7132 | 7118 | 7104 | 7089 | 14 |
| 242 | 7075 | 7061 | 7047 | 7033 | 7019 | 7005 | 6991 | 6977 | 6963 | 6949 | 14 |
| 243 | 6935 | 6921 | 6907 | 6893 | 6879 | 6866 | 6852 | 6838 | 6824 | 6810 | 14 |

## X. (*continued*).

$\{1000 \div v\}^2$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | — |
| 244 | 0·1 6797 | 6783 | 6769 | 6755 | 6742 | 6728 | 6714 | 6701 | 6687 | 6673 | 14 |
| 245 | 6660 | 6646 | 6633 | 6619 | 6605 | 6592 | 6578 | 6565 | 6551 | 6538 | 14 |
| 246 | 6525 | 6511 | 6498 | 6484 | 6471 | 6458 | 6444 | 6431 | 6418 | 6404 | 13 |
| 247 | 0·1 6391 | 6378 | 6365 | 6351 | 6338 | 6325 | 6312 | 6299 | 6285 | 6272 | 13 |
| 248 | 6259 | 6246 | 6233 | 6220 | 6207 | 6194 | 6181 | 6168 | 6155 | 6142 | 13 |
| 249 | 6129 | 6116 | 6103 | 6090 | 6077 | 6064 | 6051 | 6038 | 6026 | 6013 | 13 |
| 250 | 0·1 6000 | 5987 | 5974 | 5962 | 5949 | 5936 | 5923 | 5911 | 5898 | 5885 | 13 |
| 251 | 5873 | 5860 | 5848 | 5835 | 5822 | 5810 | 5797 | 5785 | 5772 | 5760 | 13 |
| 252 | 5747 | 5735 | 5722 | 5710 | 5697 | 5685 | 5672 | 5660 | 5648 | 5635 | 12 |
| 253 | 0·1 5623 | 5610 | 5598 | 5586 | 5574 | 5561 | 5549 | 5537 | 5524 | 5512 | 12 |
| 254 | 5500 | 5488 | 5476 | 5463 | 5451 | 5439 | 5427 | 5415 | 5403 | 5391 | 12 |
| 255 | 5379 | 5367 | 5355 | 5343 | 5331 | 5319 | 5307 | 5295 | 5283 | 5271 | 12 |
| 256 | 0·1 5259 | 5247 | 5235 | 5223 | 5211 | 5199 | 5188 | 5176 | 5164 | 5152 | 12 |
| 257 | 5140 | 5129 | 5117 | 5105 | 5093 | 5082 | 5070 | 5058 | 5047 | 5035 | 12 |
| 258 | 5023 | 5011 | 5000 | 4988 | 4977 | 4965 | 4953 | 4942 | 4930 | 4919 | 12 |
| 259 | 0·1 4907 | 4896 | 4884 | 4873 | 4861 | 4850 | 4839 | 4827 | 4816 | 4804 | 11 |
| 260 | 4793 | 4782 | 4770 | 4759 | 4747 | 4736 | 4725 | 4714 | 4702 | 4691 | 11 |
| 261 | 4680 | 4669 | 4657 | 4646 | 4635 | 4624 | 4612 | 4601 | 4590 | 4579 | 11 |
| 262 | 0·1 4568 | 4557 | 4546 | 4535 | 4524 | 4512 | 4501 | 4490 | 4479 | 4468 | 11 |
| 263 | 4457 | 4446 | 4435 | 4424 | 4413 | 4403 | 4392 | 4381 | 4370 | 4359 | 11 |
| 264 | 4348 | 4337 | 4326 | 4315 | 4305 | 4294 | 4283 | 4272 | 4261 | 4251 | 11 |
| 265 | 0·1 4240 | 4229 | 4218 | 4207 | 4197 | 4186 | 4176 | 4165 | 4154 | 4144 | 11 |
| 266 | 4133 | 4122 | 4112 | 4101 | 4091 | 4080 | 4070 | 4059 | 4048 | 4038 | 11 |
| 267 | 4027 | 4017 | 4006 | 3996 | 3985 | 3975 | 3965 | 3954 | 3944 | 3933 | 10 |
| 268 | 0·1 3923 | 3913 | 3902 | 3892 | 3881 | 3871 | 3861 | 3850 | 3840 | 3830 | 10 |
| 269 | 3820 | 3809 | 3799 | 3789 | 3779 | 3768 | 3758 | 3748 | 3738 | 3728 | 10 |
| 270 | 3717 | 3707 | 3697 | 3687 | 3677 | 3667 | 3657 | 3647 | 3637 | 3626 | 10 |
| 271 | 0·1 3616 | 3606 | 3596 | 3586 | 3576 | 3566 | 3556 | 3546 | 3536 | 3526 | 10 |
| 272 | 3516 | 3507 | 3497 | 3487 | 3477 | 3467 | 3457 | 3447 | 3437 | 3427 | 10 |
| 273 | 3418 | 3408 | 3398 | 3388 | 3378 | 3369 | 3359 | 3349 | 3339 | 3330 | 10 |
| 274 | 0·1 3320 | 3310 | 3300 | 3291 | 3281 | 3271 | 3262 | 3252 | 3242 | 3233 | 10 |
| 275 | 3223 | 3214 | 3204 | 3194 | 3185 | 3175 | 3166 | 3156 | 3147 | 3137 | 10 |
| 276 | 3127 | 3118 | 3108 | 3099 | 3090 | 3080 | 3071 | 3061 | 3052 | 3042 | 9 |
| 277 | 0·1 3033 | 3023 | 3014 | 3005 | 2995 | 2986 | 2977 | 2967 | 2958 | 2949 | 9 |
| 278 | 2939 | 2930 | 2921 | 2911 | 2902 | 2893 | 2884 | 2874 | 2865 | 2856 | 9 |
| 279 | 2847 | 2838 | 2828 | 2819 | 2810 | 2801 | 2792 | 2782 | 2773 | 2764 | 9 |
| 280 | 0·1 2755 | 2746 | 2737 | 2728 | 2719 | 2710 | 2701 | 2692 | 2683 | 2674 | 9 |
| 281 | 2664 | 2655 | 2646 | 2637 | 2628 | 2619 | 2611 | 2602 | 2593 | 2584 | 9 |
| 282 | 2575 | 2566 | 2557 | 2548 | 2539 | 2530 | 2521 | 2513 | 2504 | 2495 | 9 |
| 283 | 0·1 2486 | 2477 | 2468 | 2460 | 2451 | 2442 | 2433 | 2425 | 2416 | 2407 | 9 |
| 284 | 2398 | 2390 | 2381 | 2372 | 2363 | 2355 | 2346 | 2337 | 2329 | 2320 | 9 |

## XI.

Coefficients for the Cubic Law of the Resistance of the Air to Spherical Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ f. s. | $K_v$ | $\frac{K_v}{g}$ | $v$ f. s. | $K_v$ | $\frac{K_v}{g}$ | $v$ f. s. | $K_v$ | $\frac{K_v}{g}$ |
|---|---|---|---|---|---|---|---|---|
| 840 | 140·8 | 4·374 | 1390 | 142·7 | 4·433 | 1840 | 111·9 | 3·476 |
| to | 140·8 | 4·374 | 1400 | 142·1 | 4·414 | 1850 | 111·4 | 3·461 |
| 960 | 140·8 | 4·374 | 1410 | 141·4 | 4·393 | 1860 | 110·8 | 3·442 |
| 970 | 140·9 | 4·377 | 1420 | 140·8 | 4·374 | 1870 | 110·3 | 3·426 |
| 980 | 141·2 | 4·386 | 1430 | 140·1 | 4·352 | 1880 | 109·8 | 3·411 |
| 990 | 141·5 | 4·396 | 1440 | 139·5 | 4·334 | 1890 | 109·4 | 3·398 |
| 1000 | 142·0 | 4·411 | 1450 | 138·8 | 4·312 | 1900 | 108·9 | 3·383 |
| 1010 | 142·8 | 4·436 | 1460 | 138·1 | 4·290 | 1910 | 108·5 | 3·371 |
| 1020 | 144·0 | 4·473 | 1470 | 137·4 | 4·268 | 1920 | 108·1 | 3·358 |
| 1030 | 145·5 | 4·520 | 1480 | 136·7 | 4·247 | 1930 | 107·7 | 3·346 |
| 1040 | 147·5 | 4·582 | 1490 | 136·0 | 4·225 | 1940 | 107·3 | 3·333 |
| 1050 | 149·2 | 4·635 | 1500 | 135·3 | 4·203 | 1950 | 106·9 | 3·321 |
| 1060 | 150·5 | 4·675 | 1510 | 134·6 | 4·181 | 1960 | 106·5 | 3·308 |
| 1070 | 151·6 | 4·709 | 1520 | 133·9 | 4·160 | 1970 | 106·1 | 3·296 |
| 1080 | 152·6 | 4·740 | 1530 | 133·2 | 4·138 | 1980 | 105·7 | 3·284 |
| 1090 | 153·4 | 4·765 | 1540 | 132·5 | 4·116 | 1990 | 105·3 | 3·271 |
| 1100 | 154·1 | 4·787 | 1550 | 131·8 | 4·094 | 2000 | 104·9 | 3·259 |
| 1110 | 154·6 | 4·803 | 1560 | 131·1 | 4·073 | 2010 | 104·5 | 3·246 |
| 1120 | 155·1 | 4·818 | 1570 | 130·4 | 4·051 | 2020 | 104·1 | 3·234 |
| 1130 | 155·4 | 4·827 | 1580 | 129·7 | 4·029 | 2030 | 103·6 | 3·218 |
| 1140 | 155·7 | 4·837 | 1590 | 129·0 | 4·007 | 2040 | 103·2 | 3·206 |
| 1150 | 155·9 | 4·843 | 1600 | 128·3 | 3·986 | 2050 | 102·7 | 3·190 |
| 1160 | 156·0 | 4·846 | 1610 | 127·6 | 3·964 | 2060 | 102·2 | 3·175 |
| 1170 | 156·0 | 4·846 | 1620 | 126·9 | 3·942 | 2070 | 101·6 | 3·156 |
| 1180 | 156·0 | 4·846 | 1630 | 126·2 | 3·920 | 2080 | 101·1 | 3·141 |
| 1190 | 155·8 | 4·840 | 1640 | 125·5 | 3·899 | 2090 | 100·5 | 3·122 |
| 1200 | 155·5 | 4·831 | 1650 | 124·8 | 3·877 | 2100 | 99·9 | 3·103 |
| 1210 | 155·1 | 4·818 | 1660 | 124·1 | 3·855 | 2110 | 99·3 | 3·085 |
| 1220 | 154·6 | 4·803 | 1670 | 123·4 | 3·833 | 2120 | 98·7 | 3·066 |
| 1230 | 154·0 | 4·784 | 1680 | 122·7 | 3·812 | 2130 | 98·2 | 3·051 |
| 1240 | 153·4 | 4·765 | 1690 | 122·0 | 3·790 | 2140 | 97·6 | 3·032 |
| 1250 | 152·7 | 4·744 | 1700 | 121·3 | 3·768 | 2150 | 97·1 | 3·016 |
| 1260 | 152·0 | 4·722 | 1710 | 120·6 | 3·746 | 2160 | 96·5 | 2·998 |
| 1270 | 151·3 | 4·700 | 1720 | 119·9 | 3·725 | 2170 | 96·0 | 2·982 |
| 1280 | 150·5 | 4·675 | 1730 | 119·2 | 3·703 | 2180 | 95·4 | 2·964 |
| 1290 | 149·6 | 4·647 | 1740 | 118·5 | 3·681 | 2190 | 94·9 | 2·948 |
| 1300 | 148·7 | 4·619 | 1750 | 117·8 | 3·659 | 2200 | 94·4 | 2·933 |
| 1310 | 147·9 | 4·594 | 1760 | 117·1 | 3·638 | 2210 | 93·9 | 2·917 |
| 1320 | 147·2 | 4·573 | 1770 | 116·4 | 3·616 | 2220 | 93·4 | 2·901 |
| 1330 | 146·6 | 4·554 | 1780 | 115·7 | 3·594 | 2230 | 92·9 | 2·886 |
| 1340 | 146·0 | 4·535 | 1790 | 115·0 | 3·572 | 2240 | 92·4 | 2·870 |
| 1350 | 145·3 | 4·514 | 1800 | 114·4 | 3·554 | 2250 | 91·9 | 2·855 |
| 1360 | 144·7 | 4·495 | 1810 | 113·7 | 3·532 | 2260 | 91·4 | 2·839 |
| 1370 | 144·0 | 4·473 | 1820 | 113·1 | 3·513 | 2270 | 90·9 | 2·824 |
| 1380 | 143·4 | 4·455 | 1830 | 112·5 | 3·495 | 2280 | 90·4 | 2·808 |

## XII.

Coefficients for the Cubic Law of the Resistance of the Air to Ogival-headed Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ |
|---|---|---|---|---|---|---|---|---|
| 100 | 605·0 | 18·79 | 590 | 102·5 | 3·184 | 1360 | 107·2 | 3·330 |
| 110 | 550·0 | 17·09 | 600 | 100·8 | 3·131 | 1370 | 106·8 | 3·318 |
| 120 | 504·2 | 15·66 | 610 | 99·2 | 3·082 | 1380 | 106·3 | 3·302 |
| 130 | 465·4 | 14·46 | 620 | 97·6 | 3·032 | 1390 | 105·8 | 3·287 |
| 140 | 432·1 | 13·42 | 630 | 96·0 | 2·982 | 1400 | 105·2 | 3·268 |
| 150 | 403·3 | 12·53 | 640 | 94·5 | 2·936 | 1410 | 104·6 | 3·249 |
| 160 | 378·1 | 11·75 | 650 | 93·1 | 2·892 | 1420 | 104·0 | 3·231 |
| 170 | 355·9 | 11·06 | 660 | 91·7 | 2·849 | 1430 | 103·4 | 3·212 |
| 180 | 336·1 | 10·44 | 670 | 90·3 | 2·805 | 1440 | 102·8 | 3·193 |
| 190 | 318·4 | 9·891 | 680 | 89·0 | 2·765 | 1450 | 102·1 | 3·172 |
| 200 | 302·5 | 9·397 | 690 | 87·7 | 2·724 | 1460 | 101·4 | 3·150 |
| 210 | 288·1 | 8·950 | 700 | 86·4 | 2·684 | 1470 | 100·7 | 3·128 |
| 220 | 275·0 | 8·543 | 710 | 85·2 | 2·647 | 1480 | 99·9 | 3·103 |
| 230 | 263·0 | 8·170 | 720 | 84·0 | 2·609 | 1490 | 99·2 | 3·082 |
| 240 | 252·1 | 7·831 | 730 | 82·9 | 2·575 | 1500 | 98·4 | 3·057 |
| 250 | 242·0 | 7·518 | 740 | 81·8 | 2·541 | 1510 | 97·7 | 3·035 |
| 260 | 232·7 | 7·229 | 750 | 80·7 | 2·507 | 1520 | 96·8 | 3·007 |
| 270 | 224·1 | 6·962 | 760 | 79·6 | 2·473 | 1530 | 96·1 | 2·985 |
| 280 | 216·1 | 6·713 | 770 | 78·6 | 2·442 | 1540 | 95·3 | 2·960 |
| 290 | 208·6 | 6·480 | 780 | 77·6 | 2·411 | 1550 | 94·5 | 2·936 |
| 300 | 201·7 | 6·266 | 790 | 76·6 | 2·380 | 1560 | 93·7 | 2·911 |
| 310 | 195·2 | 6·064 | 800 | 75·6 | 2·348 | 1570 | 92·9 | 2·886 |
| 320 | 189·1 | 5·874 | 810 | 74·6 | 2·317 | 1580 | 92·1 | 2·861 |
| 330 | 183·3 | 5·694 | 820 | 73·9 | 2·296 | 1590 | 91·3 | 2·836 |
| 340 | 177·9 | 5·526 | 830 | 73·6 | 2·286 | 1600 | 90·5 | 2·811 |
| 350 | 172·9 | 5·371 | 840 | 73·6 | 2·286 | 1610 | 89·8 | 2·790 |
| 360 | 168·1 | 5·222 | to | 73·6 | 2·286 | 1620 | 89·1 | 2·768 |
| 370 | 163·5 | 5·079 | 1000 | 73·6 | 2·286 | 1630 | 88·4 | 2·746 |
| 380 | 159·2 | 4·946 | 1010 | 73·8 | 2·293 | 1640 | 87·7 | 2·724 |
| 390 | 155·1 | 4·818 | 1020 | 74·6 | 2·317 | 1650 | 87·0 | 2·703 |
| 400 | 151·3 | 4·700 | 1030 | 76·6 | 2·380 | 1660 | 86·3 | 2·681 |
| 410 | 147·6 | 4·585 | 1040 | 80·8 | 2·510 | 1670 | 85·6 | 2·659 |
| 420 | 144·0 | 4·473 | 1050 | 87·3 | 2·712 | 1680 | 84·9 | 2·637 |
| 430 | 140·7 | 4·371 | 1060 | 94·0 | 2·920 | 1690 | 84·2 | 2·616 |
| 440 | 137·5 | 4·271 | 1070 | 98·7 | 3·066 | 1700 | 83·5 | 2·594 |
| 450 | 134·4 | 4·175 | 1080 | 102·2 | 3·175 | 1710 | 82·8 | 2·572 |
| 460 | 131·5 | 4·084 | 1090 | 104·9 | 3·259 | 1720 | 82·1 | 2·550 |
| 470 | 128·7 | 3·998 | 1100 | 106·9 | 3·321 | 1730 | 81·5 | 2·532 |
| 480 | 126·0 | 3·914 | 1110 | 108·4 | 3·367 | 1740 | 80·9 | 2·513 |
| 490 | 123·5 | 3·836 | 1120 | 109·2 | 3·392 | 1750 | 80·3 | 2·495 |
| 500 | 121·0 | 3·759 | 1130 | 109·6 | 3·405 | 1760 | 79·7 | 2·476 |
| 510 | 118·6 | 3·684 | to | 109·6 | 3·405 | 1770 | 79·2 | 2·460 |
| 520 | 116·3 | 3·613 | 1290 | 109·6 | 3·405 | 1780 | 78·6 | 2·442 |
| 530 | 114·2 | 3·548 | 1300 | 109·4 | 3·398 | 1790 | 78·0 | 2·423 |
| 540 | 112·0 | 3·479 | 1310 | 109·1 | 3·389 | 1800 | 77·4 | 2·404 |
| 550 | 110 0 | 3·417 | 1320 | 108·8 | 3·380 | 1810 | 76·8 | 2·386 |
| 560 | 108 0 | 3·355 | 1330 | 108·5 | 3·371 | 1820 | 76·2 | 2·367 |
| 570 | 106·1 | 3·296 | 1340 | 108·1 | 3·358 | 1830 | 75·7 | 2·352 |
| 580 | 104·3 | 3·240 | 1350 | 107·7 | 3·346 | 1840 | 75·2 | 2·336 |

XII. (*continued*).

| $v$ f. s. | $K_v$ | $\frac{K_v}{g}$ | $v$ f. s. | $K_v$ | $\frac{K_v}{g}$ | $v$ f. s. | $K_v$ | $\frac{K_v}{g}$ |
|---|---|---|---|---|---|---|---|---|
| 1850 | 74·7 | 2·321 | 2170 | 66·3 | 2·060 | 2480 | 53·6 | 1·665 |
| 1860 | 74·3 | 2·308 | 2180 | 66·1 | 2·053 | 2490 | 53·2 | 1·653 |
| 1870 | 73·8 | 2·293 | 2190 | 66·0 | 2·050 | 2500 | 52·9 | 1·643 |
| 1880 | 73·3 | 2·277 | 2200 | 65·8 | 2·044 | 2510 | 52·7 | 1·637 |
| 1890 | 72·8 | 2·262 | 2210 | 65·6 | 2·038 | 2520 | 52·5 | 1·631 |
| 1900 | 72·2 | 2·243 | 2220 | 65·3 | 2·029 | 2530 | 52·3 | 1·625 |
| 1910 | 71·7 | 2·227 | 2230 | 65·1 | 2·022 | 2540 | 52·2 | 1·622 |
| 1920 | 71·2 | 2·212 | 2240 | 64·9 | 2·016 | 2550 | 52·0 | 1·615 |
| 1930 | 70·8 | 2·199 | 2250 | 64·6 | 2·007 | 2560 | 51·9 | 1·612 |
| 1940 | 70·4 | 2·187 | 2260 | 64·2 | 1·994 | 2570 | 51·8 | 1·609 |
| 1950 | 70·0 | 2·175 | 2270 | 63·7 | 1·979 | 2580 | 51·7 | 1·606 |
| 1960 | 69·6 | 2·162 | 2280 | 63·2 | 1·963 | 2590 | 51·6 | 1·603 |
| 1970 | 69·3 | 2·153 | 2290 | 62·7 | 1·948 | 2600 | 51·5 | 1·600 |
| 1980 | 69·0 | 2·143 | 2300 | 62·2 | 1·932 | 2610 | 51·4 | 1·597 |
| 1990 | 68·8 | 2·137 | 2310 | 61·7 | 1·917 | 2620 | 51·4 | 1·597 |
| 2000 | 68·5 | 2·128 | 2320 | 61·2 | 1·901 | 2630 | 51·4 | 1·597 |
| 2010 | 68·2 | 2·119 | 2330 | 60·7 | 1·886 | 2640 | 51·4 | 1·597 |
| 2020 | 68·0 | 2·112 | 2340 | 60·2 | 1·870 | 2650 | 51·4 | 1·597 |
| 2030 | 67·8 | 2·106 | 2350 | 59·7 | 1·855 | 2660 | 51·4 | 1·597 |
| 2040 | 67·7 | 2·103 | 2360 | 59·1 | 1·836 | 2670 | 51·4 | 1·597 |
| 2050 | 67·5 | 2·097 | 2370 | 58·6 | 1·820 | 2680 | 51·4 | 1·597 |
| 2060 | 67·4 | 2·094 | 2380 | 58·0 | 1·802 | 2690 | 51·3 | 1·594 |
| 2070 | 67·3 | 2·091 | 2390 | 57·5 | 1·786 | 2700 | 51·3 | 1·594 |
| 2080 | 67·2 | 2·088 | 2400 | 57·0 | 1·771 | 2710 | 51·3 | 1·594 |
| 2090 | 67·1 | 2·084 | 2410 | 56·5 | 1·755 | 2720 | 51·3 | 1·594 |
| 2100 | 67·0 | 2·081 | 2420 | 56·0 | 1·740 | 2730 | 51·2 | 1·591 |
| 2110 | 66·9 | 2·078 | 2430 | 55·6 | 1·727 | 2740 | 51·2 | 1·591 |
| 2120 | 66·8 | 2·075 | 2440 | 55·1 | 1·712 | 2750 | 51·2 | 1·591 |
| 2130 | 66·7 | 2·072 | 2450 | 54·7 | 1·699 | 2760 | 51·2 | 1·591 |
| 2140 | 66·6 | 2·069 | 2460 | 54·3 | 1·687 | 2770 | 51 2 | 1·591 |
| 2150 | 66·5 | 2·066 | 2470 | 53·9 | 1·674 | 2780 | 51·2 | 1·591 |
| 2160 | 66·4 | 2·063 | | | | | | |

## XIII.

Coefficients for the Cubic Law of the Resistance of the Air to Hemispherical-headed Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $\kappa_1$ | $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $\kappa_1$ | $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $\kappa_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1100 | 133·0 | 4·13 | 1·24 | 1670 | 115·0 | 3·57 | 1·34 | 1780 | 109·0 | 3·39 | 1·39 |
| 1110 | 133·0 | 4·13 | 1·23 | 1680 | 114·7 | 3·56 | 1·35 | 1790 | 108·0 | 3·36 | 1·38 |
| 1120 | 133·0 | 4·13 | 1·22 | 1690 | 114·4 | 3·55 | 1·36 | 1800 | 107·0 | 3·32 | 1·38 |
| 1130 | 133·0 | 4·13 | 1·21 | 1700 | 114·0 | 3·54 | 1·37 | 1810 | 106·0 | 3·29 | 1·38 |
| 1140 | 133·0 | 4·13 | 1·21 | 1710 | 113·6 | 3·53 | 1·37 | 1820 | 104·9 | 3·26 | 1·38 |
| 1150 | 133·0 | 4·13 | 1·21 | 1720 | 113·2 | 3·52 | 1·38 | 1830 | 103·8 | 3·22 | 1·37 |
| 1160 | 133·0 | 4·13 | 1·21 | 1730 | 112·7 | 3·50 | 1·38 | 1840 | 102·7 | 3·19 | 1·37 |
| ..... | ..... | ..... | ..... | 1740 | 112·1 | 3·48 | 1·39 | 1850 | 101·6 | 3·16 | 1·36 |
| 1640 | 115·6 | 3·59 | 1·32 | 1750 | 111·4 | 3·46 | 1·39 | 1860 | 100·6 | 3·13 | 1·35 |
| 1650 | 115·4 | 3·58 | 1·33 | 1760 | 110·7 | 3·44 | 1·39 | 1870 | 99·6 | 3·09 | 1·35 |
| 1660 | 115·2 | 3·58 | 1·33 | 1770 | 109·9 | 3·41 | 1·39 | | | | |

## XIV.

Coefficients for the Cubic Law of the Resistance of the Air to Flat-headed Projectiles. ($\omega = 534{\cdot}22$ grains.)

| $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $\kappa_2$ | $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $\kappa_2$ | $v$ *f. s.* | $K_v$ | $\frac{K_v}{g}$ | $\kappa_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1530 | 174·3 | 5·41 | 1·81 | 1650 | 173·6 | 5·39 | 2·00 | 1760 | 171·5 | 5·33 | 2·15 |
| 1540 | 174·4 | 5·42 | 1·83 | 1660 | 173·5 | 5·39 | 2·01 | 1770 | 171·2 | 5·32 | 2·16 |
| 1550 | 174·4 | 5·42 | 1·85 | 1670 | 173·3 | 5·38 | 2·02 | 1780 | 170·9 | 5·31 | 2·17 |
| 1560 | 174·5 | 5·42 | 1·86 | 1680 | 173·2 | 5·38 | 2·04 | 1790 | 170·5 | 5·29 | 2·19 |
| 1570 | 174·5 | 5·42 | 1·88 | 1690 | 173·0 | 5·37 | 2·05 | 1800 | 170·0 | 5·28 | 2·20 |
| 1580 | 174·4 | 5·42 | 1·89 | 1700 | 172·9 | 5·37 | 2·07 | 1810 | 169·5 | 5·27 | 2·21 |
| 1590 | 174·3 | 5·41 | 1·91 | 1710 | 172·7 | 5·36 | 2·09 | 1820 | 168·9 | 5·25 | 2·22 |
| 1600 | 174·2 | 5·41 | 1·92 | 1720 | 172·6 | 5·36 | 2·10 | 1830 | 168·3 | 5·23 | 2·22 |
| 1610 | 174·1 | 5·41 | 1·94 | 1730 | 172·4 | 5·36 | 2·12 | 1840 | 167·6 | 5·21 | 2·23 |
| 1620 | 174·0 | 5·41 | 1·95 | 1740 | 172·1 | 5·35 | 2·13 | 1850 | 166·8 | 5·18 | 2·23 |
| 1630 | 173·9 | 5·40 | 1·97 | 1750 | 171·8 | 5·34 | 2·14 | 1860 | 165·9 | 5·15 | 2·23 |
| 1640 | 173·7 | 5·40 | 1·98 | | | | | | | | |

## XV.

| $P_\phi = 3\tan\phi + \tan^3\phi$ | | | | $P_\phi = 3\tan\phi + \tan^3\phi$ | | | |
|---|---|---|---|---|---|---|---|
| $\phi$ | $P_\phi$ | Log $P_\phi$ | Log $\Delta P_\phi$ | $\phi$ | $P_\phi$ | Log $P_\phi$ | Log $\Delta P_\phi$ |
| 1° | ·05237 | 8·71909 | 8·71961 | 41° | 3·26475 | 0·51385 | 9·22128 |
| 2 | ·10481 | 9·02038 | 8·72067 | 42 | 3·43119 | 0·53545 | 9·24859 |
| 3 | ·15737 | 9·19691 | 8·72226 | 43 | 3·60845 | 0·55732 | 9·27687 |
| 4 | ·21012 | 9·32247 | 8·72439 | 44 | 3·79762 | 0·57951 | 9·30617 |
| 5 | ·26314 | 9·42018 | 8·72704 | 45 | 4·00000 | 0·60206 | 9·33649 |
| 6 | ·31647 | 9·50034 | 8·73023 | 46 | 4·21701 | 0·62501 | 9·36790 |
| 7 | ·37021 | 9·56844 | 8·73394 | 47 | 4·45030 | 0·64839 | 9·40042 |
| 8 | ·42440 | 9·62777 | 8·73821 | 48 | 4·70173 | 0·67226 | 9·43410 |
| 9 | ·47913 | 9·68045 | 8·74302 | 49 | 4·97344 | 0·69666 | 9·46900 |
| 10 | ·53446 | 9·72792 | 8·74836 | 50 | 5·26788 | 0·72164 | 9·50514 |
| 11 | ·59049 | 9·77121 | 8·75426 | 51 | 5·58787 | 0·74725 | 9·54260 |
| 12 | ·64727 | 9·81109 | 8·76070 | 52 | 5·93669 | 0·77355 | 9·58142 |
| 13 | ·70491 | 9·84813 | 8·76770 | 53 | 6·31812 | 0·80059 | 9·62167 |
| 14 | ·76348 | 9·88280 | 8·77527 | 54 | 6·73660 | 0·82844 | 9·66342 |
| 15 | ·82309 | 9·91545 | 8·78338 | 55 | 7·19730 | 0·85717 | 9·70674 |
| 16 | ·88381 | 9·94636 | 8·79208 | 56 | 7·70633 | 0·88685 | 9·75171 |
| 17 | ·94577 | 9·97579 | 8·80136 | 57 | 8·27090 | 0·91755 | 9·79843 |
| 18 | 1·00906 | 0·00392 | 8·81121 | 58 | 8·89957 | 0·94937 | 9·84697 |
| 19 | 1·07381 | 0·03093 | 8·82164 | 59 | 9·60260 | 0·98239 | 9·89746 |
| 20 | 1·14013 | 0·05695 | 8·83269 | 60 | 10·3923 | 1·01671 | 9·95001 |
| 21 | 1·20816 | 0·08212 | 8·84433 | 61 | 11·2836 | 1·05245 | 0·00475 |
| 22 | 1·27803 | 0·10654 | 8·85658 | 62 | 12·2946 | 1·08971 | 0·06179 |
| 23 | 1·34991 | 0·13030 | 8·86945 | 63 | 13·4475 | 1·12864 | 0·12136 |
| 24 | 1·42394 | 0·15349 | 8·88295 | 64 | 14·7699 | 1·16938 | 0·18358 |
| 25 | 1·50032 | 0·17618 | 8·89709 | 65 | 16·2959 | 1·21208 | 0·24864 |
| 26 | 1·57922 | 0·19844 | 8·91188 | 66 | 18·0687 | 1·25693 | 0·31681 |
| 27 | 1·66086 | 0·22033 | 8·92733 | 67 | 20·1426 | 1·30412 | 0·38830 |
| 28 | 1·74545 | 0·24191 | 8·94346 | 68 | 22·5878 | 1·35387 | 0·46343 |
| 29 | 1·83324 | 0·26322 | 8·96027 | 69 | 25·4947 | 1·40645 | 0·54249 |
| 30 | 1·92450 | 0·28432 | 8·97778 | 70 | 28·9820 | 1·46213 | 0·62593 |
| 31 | 2·01951 | 0·30525 | 8·99600 | 71 | 33·2080 | 1·52124 | 0·71410 |
| 32 | 2·11860 | 0·32605 | 9·01495 | 72 | 38·3853 | 1·58417 | 0·80756 |
| 33 | 2·22210 | 0·34676 | 9·03464 | 73 | 44·8057 | 1·65133 | 0·90691 |
| 34 | 2·33040 | 0·36743 | 9·05510 | 74 | 52·8763 | 1·72326 | 1·01288 |
| 35 | 2·44393 | 0·38809 | 9·07633 | 75 | 63·1771 | 1·80056 | 1·12626 |
| 36 | 2·56314 | 0·40877 | 9·09837 | 76 | 76·5513 | 1·88395 | 1·24819 |
| 37 | 2·68856 | 0·42952 | 9·12122 | 77 | 94·2603 | 1·97433 | 1·37992 |
| 38 | 2·82076 | 0·45037 | 9·14491 | 78 | 118·244 | 2·07278 | 1·52307 |
| 39 | 2·96037 | 0·47135 | 9·16947 | 79 | 151·592 | 2·18068 | 1·67970 |
| 40 | 3·10810 | 0·49250 | 9·19492 | 80 | 199·422 | 2·29977 | |

## XVI.

Table for $\gamma = 0{\cdot}00$ is the same as that for $\lambda = 0{\cdot}00$ (p. 8).

$\gamma = 0{\cdot}01$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 10119 | 5082 | 10059 | 1434 |
| 44 | 9767 | 4736 | 9712 | 1408 |
| 43 | 9428 | 4413 | 9376 | 1384 |
| 42 | 9098 | 4111 | 9051 | 1362 |
| 41 | 8780 | 3830 | 8736 | 1340 |
| 40 | 8471 | 3566 | 8431 | 1320 |
| 39 | 8172 | 3320 | 8135 | 1300 |
| 38 | 7881 | 3088 | 7847 | 1282 |
| 37 | 7599 | 2872 | 7567 | 1264 |
| 36 | 7324 | 2668 | 7294 | 1247 |
| 35 | 7056 | 2477 | 7029 | 1231 |
| 34 | 6795 | 2297 | 6770 | 1216 |
| 33 | 6540 | 2129 | 6517 | 1201 |
| 32 | 6291 | 1970 | 6270 | 1188 |
| 31 | 6047 | 1821 | 6028 | 1175 |

$\gamma = 0{\cdot}02$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 10244 | 5168 | 10121 | 1454 |
| 44 | 9881 | 4812 | 9768 | 1427 |
| 43 | 9532 | 4481 | 9428 | 1402 |
| 42 | 9195 | 4172 | 9099 | 1378 |
| 41 | 8869 | 3883 | 8780 | 1355 |
| 40 | 8554 | 3614 | 8472 | 1333 |
| 39 | 8248 | 3362 | 8173 | 1313 |
| 38 | 7952 | 3126 | 7882 | 1294 |
| 37 | 7664 | 2905 | 7599 | 1275 |
| 36 | 7384 | 2698 | 7324 | 1258 |
| 35 | 7111 | 2503 | 7056 | 1241 |
| 34 | 6846 | 2321 | 6795 | 1226 |
| 33 | 6587 | 2149 | 6540 | 1211 |
| 32 | 6334 | 1988 | 6291 | 1197 |
| 31 | 6087 | 1837 | 6048 | 1183 |

$\gamma = 0{\cdot}03$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 10374 | 5259 | 10184 | 1476 |
| 44 | 10001 | 4892 | 9827 | 1448 |
| 43 | 9642 | 4551 | 9482 | 1421 |
| 42 | 9296 | 4234 | 9148 | 1395 |
| 41 | 8962 | 3939 | 8826 | 1371 |
| 40 | 8639 | 3663 | 8514 | 1348 |
| 39 | 8327 | 3406 | 8211 | 1327 |
| 38 | 8024 | 3165 | 7918 | 1307 |
| 37 | 7731 | 2940 | 7632 | 1288 |
| 36 | 7445 | 2728 | 7355 | 1270 |
| 35 | 7168 | 2530 | 7084 | 1252 |
| 34 | 6898 | 2345 | 6821 | 1236 |
| 33 | 6635 | 2171 | 6564 | 1220 |
| 32 | 6378 | 2007 | 6313 | 1205 |
| 31 | 6127 | 1854 | 6068 | 1191 |

$\gamma = 0{\cdot}04$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 10510 | 5354 | 10250 | 1499 |
| 44 | 10126 | 4976 | 9887 | 1469 |
| 43 | 9756 | 4626 | 9537 | 1440 |
| 42 | 9401 | 4300 | 9200 | 1413 |
| 41 | 9059 | 3997 | 8873 | 1388 |
| 40 | 8728 | 3715 | 8557 | 1364 |
| 39 | 8409 | 3451 | 8251 | 1342 |
| 38 | 8099 | 3205 | 7954 | 1321 |
| 37 | 7800 | 2975 | 7666 | 1301 |
| 36 | 7509 | 2760 | 7386 | 1281 |
| 35 | 7226 | 2558 | 7113 | 1263 |
| 34 | 6951 | 2370 | 6847 | 1246 |
| 33 | 6684 | 2192 | 6588 | 1230 |
| 32 | 6423 | 2026 | 6335 | 1215 |
| 31 | 6169 | 1870 | 6088 | 1200 |

XVI. (*continued*).

| $\gamma = 0{\cdot}05$ | | | | | $\gamma = 0{\cdot}05$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 45° | 10653 | 5454 | 10319 | 1523 | 1° | 175 | 1·5 | 175 | 999 |
| 44 | 10256 | 5065 | 9950 | 1491 | 2 | 349 | 6·1 | 349 | 999 |
| 43 | 9876 | 4704 | 9595 | 1461 | 3 | 523 | 13·7 | 523 | 999 |
| 42 | 9511 | 4369 | 9252 | 1433 | 4 | 697 | 24·3 | 698 | 999 |
| 41 | 9159 | 4058 | 8922 | 1406 | 5 | 871 | 38·1 | 873 | 1000 |
| 40 | 8820 | 3768 | 8602 | 1381 | 6 | 1046 | 54·9 | 1048 | 1000 |
| 39 | 8493 | 3499 | 8292 | 1357 | 7 | 1220 | 74·8 | 1224 | 1001 |
| 38 | 8177 | 3247 | 7992 | 1335 | 8 | 1396 | 97·8 | 1401 | 1003 |
| 37 | 7871 | 3012 | 7701 | 1314 | 9 | 1571 | 124·1 | 1578 | 1005 |
| 36 | 7574 | 2793 | 7418 | 1294 | 10 | 1748 | 153·7 | 1756 | 1007 |
| 35 | 7286 | 2587 | 7142 | 1275 | 11 | 1925 | 186·5 | 1935 | 1009 |
| 34 | 7006 | 2395 | 6874 | 1257 | 12 | 2103 | 222·7 | 2114 | 1012 |
| 33 | 6734 | 2215 | 6613 | 1240 | 13 | 2282 | 262·5 | 2296 | 1015 |
| 32 | 6469 | 2046 | 6358 | 1224 | 14 | 2463 | 305·7 | 2478 | 1018 |
| 31 | 6211 | 1888 | 6109 | 1209 | 15 | 2644 | 352·6 | 2662 | 1021 |
| 30 | 5959 | 1739 | 5865 | 1194 | 16 | 2827 | 403·3 | 2847 | 1025 |
| 29 | 5713 | 1600 | 5627 | 1181 | 17 | 3011 | 457·9 | 3034 | 1030 |
| 28 | 5473 | 1470 | 5394 | 1168 | 18 | 3197 | 516·5 | 3223 | 1034 |
| 27 | 5237 | 1347 | 5166 | 1156 | 19 | 3385 | 579·3 | 3414 | 1039 |
| 26 | 5007 | 1232 | 4941 | 1144 | 20 | 3574 | 646·4 | 3607 | 1045 |
| 25 | 4781 | 1124 | 4721 | 1133 | 21 | 3766 | 718·0 | 3802 | 1050 |
| 24 | 4559 | 1023 | 4505 | 1122 | 22 | 3959 | 794·3 | 4000 | 1057 |
| 23 | 4341 | 928·5 | 4293 | 1112 | 23 | 4155 | 875·5 | 4200 | 1063 |
| 22 | 4127 | 839·8 | 4083 | 1103 | 24 | 4354 | 961·8 | 4403 | 1070 |
| 21 | 3917 | 756·9 | 3877 | 1094 | 25 | 4555 | 1053 | 4609 | 1077 |
| 20 | 3710 | 679·5 | 3674 | 1086 | 26 | 4759 | 1151 | 4818 | 1085 |
| 19 | 3506 | 607·2 | 3474 | 1078 | 27 | 4966 | 1254 | 5030 | 1093 |
| 18 | 3305 | 539·9 | 3277 | 1070 | 28 | 5176 | 1363 | 5246 | 1101 |
| 17 | 3106 | 477·4 | 3082 | 1063 | 29 | 5389 | 1479 | 5465 | 1110 |
| 16 | 2910 | 419·3 | 2889 | 1056 | 30 | 5606 | 1602 | 5689 | 1120 |
| 15 | 2717 | 365·7 | 2698 | 1050 | 31 | 5827 | 1732 | 5917 | 1130 |
| 14 | 2525 | 316·2 | 2509 | 1044 | 32 | 6052 | 1870 | 6149 | 1140 |
| 13 | 2336 | 270·8 | 2322 | 1039 | 33 | 6281 | 2016 | 6386 | 1151 |
| 12 | 2149 | 229·2 | 2137 | 1034 | 34 | 6515 | 2170 | 6628 | 1163 |
| 11 | 1963 | 191·4 | 1954 | 1029 | 35 | 6753 | 2334 | 6876 | 1175 |
| 10 | 1779 | 157·3 | 1771 | 1025 | 36 | 6996 | 2508 | 7129 | 1187 |
| 9 | 1597 | 126·8 | 1590 | 1021 | 37 | 7245 | 2692 | 7388 | 1201 |
| 8 | 1415 | 99·7 | 1410 | 1017 | 38 | 7500 | 2887 | 7654 | 1214 |
| 7 | 1236 | 76·0 | 1232 | 1014 | 39 | 7760 | 3095 | 7926 | 1229 |
| 6 | 1057 | 55·6 | 1054 | 1011 | 40 | 8027 | 3315 | 8206 | 1244 |
| 5 | 879 | 38·5 | 877 | 1008 | 41 | 8300 | 3548 | 8494 | 1260 |
| 4 | 702 | 24·6 | 701 | 1006 | 42 | 8581 | 3797 | 8789 | 1277 |
| 3 | 526 | 13·8 | 525 | 1004 | 43 | 8869 | 4061 | 9093 | 1294 |
| 2 | 350 | 6·1 | 350 | 1002 | 44 | 9166 | 4342 | 9407 | 1312 |
| 1 | 175 | 1·5 | 175 | 1001 | 45 | 9470 | 4641 | 9730 | 1331 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |

## XVI. (*continued*).

| $\gamma = 0{\cdot}05$ | | | | | $\gamma = 0{\cdot}07$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 46° | 9784 | 4961 | 10064 | 1351 | 45° | 10962 | 5674 | 10465 | 1577 |
| 47 | 10107 | 5301 | 10409 | 1371 | 44 | 10537 | 5257 | 10083 | 1541 |
| 48 | 10441 | 5665 | 10766 | 1393 | 43 | 10132 | 4873 | 9717 | 1507 |
| 49 | 10785 | 6054 | 11136 | 1416 | 42 | 9744 | 4517 | 9364 | 1475 |
| 50 | 11140 | 6470 | 11519 | 1439 | 41 | 9372 | 4188 | 9024 | 1445 |
| 51 | 11508 | 6916 | 11918 | 1464 | 40 | 9015 | 3883 | 8695 | 1417 |
| 52 | 11888 | 7395 | 12332 | 1489 | 39 | 8672 | 3600 | 8378 | 1390 |
| 53 | 12282 | 7909 | 12763 | 1516 | 38 | 8340 | 3336 | 8071 | 1365 |
| 54 | 12691 | 8461 | 13212 | 1544 | 37 | 8020 | 3091 | 7773 | 1342 |
| 55 | 13115 | 9056 | 13680 | 1574 | 36 | 7711 | 2862 | 7484 | 1320 |
| 56 | 13556 | 9697 | 14170 | 1604 | 35 | 7412 | 2648 | 7203 | 1300 |
| 57 | 14014 | 10389 | 14682 | 1636 | 34 | 7122 | 2449 | 6930 | 1281 |
| 58 | 14491 | 11138 | 15219 | 1669 | 33 | 6840 | 2262 | 6664 | 1262 |
| 59 | 14987 | 11948 | 15782 | 1704 | 32 | 6566 | 2087 | 6404 | 1244 |
| 60 | 15504 | 12826 | 16374 | 1740 | 31 | 6299 | 1924 | 6152 | 1227 |

| $\gamma = 0{\cdot}06$ | | | | | $\gamma = 0{\cdot}08$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 45° | 10803 | 5561 | 10390 | 1550 | 45° | 11129 | 5795 | 10543 | 1608 |
| 44 | 10393 | 5158 | 10015 | 1515 | 44 | 10689 | 5362 | 10154 | 1569 |
| 43 | 10001 | 4786 | 9655 | 1483 | 43 | 10270 | 4964 | 9781 | 1532 |
| 42 | 9625 | 4441 | 9307 | 1453 | 42 | 9869 | 4597 | 9422 | 1498 |
| 41 | 9264 | 4122 | 8972 | 1425 | 41 | 9486 | 4258 | 9077 | 1466 |
| 40 | 8916 | 3825 | 8648 | 1399 | 40 | 9119 | 3944 | 8744 | 1436 |
| 39 | 8581 | 3548 | 8334 | 1374 | 39 | 8766 | 3653 | 8423 | 1408 |
| 38 | 8257 | 3291 | 8031 | 1350 | 38 | 8426 | 3383 | 8111 | 1382 |
| 37 | 7944 | 3051 | 7736 | 1328 | 37 | 8099 | 3132 | 7810 | 1357 |
| 36 | 7642 | 2827 | 7450 | 1307 | 36 | 7783 | 2898 | 7518 | 1334 |
| 35 | 7348 | 2617 | 7172 | 1287 | 35 | 7477 | 2680 | 7234 | 1313 |
| 34 | 7063 | 2421 | 6902 | 1269 | 34 | 7181 | 2477 | 6958 | 1292 |
| 33 | 6786 | 2238 | 6638 | 1251 | 33 | 6894 | 2287 | 6690 | 1273 |
| 32 | 6517 | 2067 | 6381 | 1234 | 32 | 6616 | 2109 | 6429 | 1255 |
| 31 | 6255 | 1906 | 6130 | 1218 | 31 | 6345 | 1943 | 6174 | 1237 |

XVI. (*continued*).

| $\gamma = 0{\cdot}09$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 45° | 11307 | 5923 | 10624 | 1641 |
| 44 | 10849 | 5473 | 10228 | 1599 |
| 43 | 10414 | 5061 | 9848 | 1559 |
| 42 | 10000 | 4681 | 9483 | 1522 |
| 41 | 9605 | 4332 | 9133 | 1488 |
| 40 | 9227 | 4009 | 8795 | 1457 |
| 39 | 8864 | 3710 | 8469 | 1427 |
| 38 | 8516 | 3432 | 8154 | 1399 |
| 37 | 8181 | 3175 | 7849 | 1373 |
| 36 | 7857 | 2936 | 7553 | 1349 |
| 35 | 7545 | 2713 | 7266 | 1326 |
| 34 | 7243 | 2506 | 6988 | 1304 |
| 33 | 6951 | 2312 | 6717 | 1284 |
| 32 | 6667 | 2131 | 6453 | 1265 |
| 31 | 6391 | 1962 | 6196 | 1247 |

| $\gamma = 0{\cdot}10$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 45° | 11495 | 6061 | 10709 | 1677 |
| 44 | 11018 | 5592 | 10305 | 1630 |
| 43 | 10567 | 5163 | 9918 | 1587 |
| 42 | 10138 | 4770 | 9547 | 1548 |
| 41 | 9730 | 4409 | 9190 | 1512 |
| 40 | 9340 | 4076 | 8847 | 1478 |
| 39 | 8967 | 3769 | 8516 | 1447 |
| 38 | 8609 | 3484 | 8197 | 1417 |
| 37 | 8265 | 3220 | 7888 | 1390 |
| 36 | 7934 | 2975 | 7589 | 1364 |
| 35 | 7615 | 2747 | 7300 | 1340 |
| 34 | 7307 | 2536 | 7018 | 1318 |
| 33 | 7009 | 2338 | 6745 | 1297 |
| 32 | 6720 | 2154 | 6478 | 1277 |
| 31 | 6439 | 1982 | 6219 | 1258 |
| 30 | 6167 | 1822 | 5966 | 1240 |
| 29 | 5903 | 1672 | 5719 | 1223 |
| 28 | 5645 | 1532 | 5478 | 1207 |
| 27 | 5394 | 1402 | 5242 | 1192 |
| 26 | 5148 | 1279 | 5010 | 1178 |

| $\gamma = 0{\cdot}10$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 25° | 4909 | 1165 | 4784 | 1165 |
| 24 | 4675 | 1058 | 4562 | 1152 |
| 23 | 4445 | 958·6 | 4344 | 1140 |
| 22 | 4221 | 865·5 | 4129 | 1129 |
| 21 | 4001 | 778·8 | 3918 | 1118 |
| 20 | 3784 | 697·9 | 3711 | 1108 |
| 19 | 3572 | 622·7 | 3507 | 1098 |
| 18 | 3363 | 552·8 | 3305 | 1089 |
| 17 | 3158 | 488·0 | 3107 | 1081 |
| 16 | 2955 | 428·0 | 2911 | 1073 |
| 15 | 2756 | 372·7 | 2717 | 1065 |
| 14 | 2559 | 321·8 | 2526 | 1058 |
| 13 | 2365 | 275·2 | 2336 | 1052 |
| 12 | 2173 | 232·6 | 2149 | 1045 |
| 11 | 1983 | 194·0 | 1963 | 1040 |
| 10 | 1796 | 159·3 | 1779 | 1034 |
| 9 | 1610 | 128·2 | 1597 | 1029 |
| 8 | 1426 | 100·7 | 1416 | 1025 |
| 7 | 1243 | 76·7 | 1236 | 1020 |
| 6 | 1062 | 56·0 | 1057 | 1016 |
| 5 | 883 | 38·7 | 879 | 1013 |
| 4 | 704 | 24·7 | 702 | 1010 |
| 3 | 527 | 13·8 | 526 | 1007 |
| 2 | 350 | 6·1 | 350 | 1004 |
| 1 | 175 | 1·5 | 175 | 1002 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 174 | 1·5 | 174 | 998 |
| 2 | 348 | 6·1 | 349 | 997 |
| 3 | 521 | 13·6 | 523 | 996 |
| 4 | 694 | 24·2 | 697 | 996 |
| 5 | 867 | 37·8 | 871 | 995 |
| 6 | 1040 | 54·5 | 1046 | 995 |
| 7 | 1213 | 74·2 | 1220 | 995 |
| 8 | 1386 | 97·0 | 1396 | 996 |
| 9 | 1559 | 122·8 | 1572 | 997 |
| 10 | 1733 | 151·9 | 1748 | 998 |
| 11 | 1907 | 184·2 | 1925 | 999 |
| 12 | 2082 | 219·7 | 2104 | 1001 |
| 13 | 2257 | 258·6 | 2283 | 1003 |
| 14 | 3433 | 300·8 | 2463 | 1006 |
| 15 | 2610 | 346·6 | 2644 | 1008 |

## XVI. (*continued*).

$\gamma = 0{\cdot}10$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 16° | 2788 | 396·0 | 2827 | 1011 |
| 17 | 2967 | 449·0 | 3012 | 1015 |
| 18 | 3147 | 505·9 | 3198 | 1018 |
| 19 | 3329 | 566·7 | 3386 | 1022 |
| 20 | 3512 | 631·5 | 3575 | 1027 |
| 21 | 3697 | 700·6 | 3767 | 1031 |
| 22 | 3883 | 774·1 | 3961 | 1036 |
| 23 | 4072 | 852·1 | 4157 | 1041 |
| 24 | 4262 | 934·8 | 4356 | 1047 |
| 25 | 4455 | 1023 | 4557 | 1053 |
| 26 | 4649 | 1115 | 4761 | 1060 |
| 27 | 4846 | 1214 | 4969 | 1066 |
| 28 | 5046 | 1318 | 5179 | 1073 |
| 29 | 5249 | 1428 | 5393 | 1081 |
| 30 | 5454 | 1544 | 5611 | 1089 |
| 31 | 5663 | 1667 | 5832 | 1097 |
| 32 | 5874 | 1797 | 6058 | 1106 |
| 33 | 6090 | 1934 | 6288 | 1115 |
| 34 | 6309 | 2079 | 6522 | 1125 |
| 35 | 6531 | 2232 | 6761 | 1135 |
| 36 | 6758 | 2394 | 7006 | 1146 |
| 37 | 6990 | 2565 | 7256 | 1157 |
| 38 | 7225 | 2746 | 7511 | 1168 |
| 39 | 7466 | 2937 | 7773 | 1180 |
| 40 | 7712 | 3140 | 8042 | 1193 |
| 41 | 7963 | 3354 | 8317 | 1206 |
| 42 | 8219 | 3581 | 8599 | 1220 |
| 43 | 8482 | 3822 | 8890 | 1234 |
| 44 | 8751 | 4077 | 9189 | 1249 |
| 45 | 9027 | 4348 | 9496 | 1264 |
| 46 | 9309 | 4635 | 9813 | 1280 |
| 47 | 9599 | 4941 | 10140 | 1297 |
| 48 | 9896 | 5266 | 10477 | 1314 |
| 49 | 10202 | 5611 | 10825 | 1332 |
| 50 | 10516 | 5979 | 11186 | 1351 |
| 51 | 10839 | 6371 | 11559 | 1370 |
| 52 | 11172 | 6789 | 11946 | 1391 |
| 53 | 11514 | 7236 | 12348 | 1411 |
| 54 | 11867 | 7713 | 12765 | 1433 |
| 55 | 12231 | 8223 | 13199 | 1455 |

$\gamma = 0{\cdot}10$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 56° | 12607 | 8769 | 13651 | 1478 |
| 57 | 12994 | 9355 | 14123 | 1502 |
| 58 | 13394 | 9983 | 14615 | 1526 |
| 59 | 13808 | 10658 | 15129 | 1551 |
| 60 | 14235 | 11383 | 15667 | 1577 |

$\gamma = 0{\cdot}12$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 11912 | 6369 | 10894 | 1759 |
| 44 | 11390 | 5856 | 10471 | 1703 |
| 43 | 10899 | 5390 | 10067 | 1652 |
| 42 | 10436 | 4966 | 9682 | 1606 |
| 41 | 9998 | 4578 | 9312 | 1564 |
| 40 | 9581 | 4222 | 8958 | 1525 |
| 39 | 9185 | 3895 | 8617 | 1490 |
| 38 | 8806 | 3594 | 8289 | 1456 |
| 37 | 8444 | 3316 | 7972 | 1426 |
| 36 | 8096 | 3059 | 7665 | 1397 |
| 35 | 7762 | 2820 | 7368 | 1371 |
| 34 | 7440 | 2599 | 7081 | 1346 |
| 33 | 7130 | 2394 | 6802 | 1322 |
| 32 | 6830 | 2202 | 6530 | 1300 |
| 31 | 6539 | 2024 | 6266 | 1280 |
| 30 | 6258 | 1859 | 6009 | 1260 |
| 29 | 5985 | 1704 | 5758 | 1242 |
| 28 | 5719 | 1560 | 5513 | 1225 |
| 27 | 5461 | 1425 | 5274 | 1208 |
| 26 | 5209 | 1300 | 5040 | 1193 |
| 25 | 4964 | 1183 | 4810 | 1179 |
| 24 | 4724 | 1073 | 4585 | 1165 |
| 23 | 4490 | 971·5 | 4365 | 1152 |
| 22 | 4260 | 876·5 | 4148 | 1140 |
| 21 | 4036 | 788·0 | 3936 | 1129 |
| 20 | 3816 | 705·7 | 3726 | 1118 |

XVI. (*continued*).

$\gamma = 0{\cdot}14$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 12396 | 6734 | 11102 | 1859 |
| 44 | 11815 | 6163 | 10655 | 1790 |
| 43 | 11275 | 5650 | 10232 | 1728 |
| 42 | 10770 | 5187 | 9829 | 1674 |
| 41 | 10296 | 4768 | 9445 | 1624 |
| 40 | 9848 | 4385 | 9078 | 1579 |
| 39 | 9425 | 4036 | 8725 | 1538 |
| 38 | 9022 | 3716 | 8386 | 1500 |
| 37 | 8638 | 3421 | 8060 | 1466 |
| 36 | 8271 | 3150 | 7745 | 1433 |
| 35 | 7920 | 2899 | 7441 | 1404 |
| 34 | 7583 | 2667 | 7147 | 1376 |
| 33 | 7259 | 2453 | 6862 | 1350 |
| 32 | 6947 | 2254 | 6585 | 1326 |
| 31 | 6645 | 2069 | 6316 | 1303 |
| 30 | 6354 | 1897 | 6054 | 1282 |
| 29 | 6071 | 1737 | 5799 | 1262 |
| 28 | 5797 | 1589 | 5550 | 1244 |
| 27 | 5531 | 1450 | 5307 | 1226 |
| 26 | 5273 | 1321 | 5070 | 1209 |
| 25 | 5021 | 1201 | 4837 | 1194 |
| 24 | 4775 | 1089 | 4610 | 1179 |
| 23 | 4535 | 984·8 | 4387 | 1165 |
| 22 | 4301 | 887·8 | 4168 | 1151 |
| 21 | 4072 | 797·6 | 3953 | 1139 |
| 20 | 3848 | 713·7 | 3742 | 1128 |

$\gamma = 0{\cdot}16$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 12970 | 7175 | 11339 | 1988 |
| 44 | 12312 | 6528 | 10863 | 1899 |
| 43 | 11708 | 5955 | 10416 | 1822 |
| 42 | 11150 | 5444 | 9993 | 1755 |
| 41 | 10631 | 4985 | 9591 | 1695 |
| 40 | 10146 | 4570 | 9208 | 1642 |
| 39 | 9689 | 4193 | 8842 | 1594 |
| 38 | 9258 | 3850 | 8491 | 1550 |
| 37 | 8850 | 3537 | 8155 | 1510 |
| 36 | 8461 | 3249 | 7831 | 1474 |

$\gamma = 0{\cdot}16$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 35° | 8091 | 2985 | 7519 | 1440 |
| 34 | 7737 | 2742 | 7217 | 1409 |
| 33 | 7397 | 2517 | 6925 | 1380 |
| 32 | 7071 | 2309 | 6642 | 1354 |
| 31 | 6757 | 2117 | 6368 | 1329 |
| 30 | 6454 | 1938 | 6101 | 1305 |
| 29 | 6162 | 1773 | 5841 | 1284 |
| 28 | 5879 | 1619 | 5588 | 1263 |
| 27 | 5605 | 1476 | 5342 | 1244 |
| 26 | 5339 | 1344 | 5101 | 1226 |
| 25 | 5080 | 1220 | 4865 | 1209 |
| 24 | 4828 | 1105 | 4635 | 1193 |
| 23 | 4583 | 998·7 | 4409 | 1178 |
| 22 | 4343 | 899·6 | 4188 | 1164 |
| 21 | 4110 | 807·5 | 3971 | 1151 |
| 20 | 3881 | 722·0 | 3758 | 1138 |

$\gamma = 0{\cdot}18$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 45° | 13677 | 7732 | 11616 | 2162 |
| 44 | 12907 | 6976 | 11102 | 2040 |
| 43 | 12217 | 6320 | 10624 | 1939 |
| 42 | 11590 | 5746 | 10175 | 1854 |
| 41 | 11014 | 5236 | 9752 | 1780 |
| 40 | 10481 | 4781 | 9351 | 1716 |
| 39 | 9985 | 4371 | 8969 | 1658 |
| 38 | 9520 | 4001 | 8605 | 1607 |
| 37 | 9082 | 3665 | 8257 | 1561 |
| 36 | 8668 | 3359 | 7922 | 1519 |
| 35 | 8276 | 3079 | 7601 | 1481 |
| 34 | 7902 | 2822 | 7291 | 1446 |
| 33 | 7545 | 2586 | 6992 | 1414 |
| 32 | 7204 | 2368 | 6702 | 1384 |
| 31 | 6876 | 2168 | 6422 | 1356 |
| 30 | 6561 | 1982 | 6150 | 1331 |
| 29 | 6258 | 1810 | 5885 | 1307 |
| 28 | 5965 | 1651 | 5628 | 1284 |
| 27 | 5682 | 1504 | 5378 | 1263 |
| 26 | 5408 | 1367 | 5133 | 1244 |

XVI. (*continued*).

| $\gamma = 0{\cdot}18$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 25° | 5142 | 1240 | 4894 | 1225 |
| 24 | 4883 | 1123 | 4661 | 1208 |
| 23 | 4632 | 1013 | 4433 | 1192 |
| 22 | 4387 | 911·8 | 4209 | 1177 |
| 21 | 4149 | 817·8 | 3989 | 1163 |
| 20 | 3915 | 730·6 | 3774 | 1149 |

| $\gamma = 0{\cdot}20$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 45° | 14592 | 8474 | 11954 | 2418 |
| 44 | 13650 | 7548 | 11385 | 2235 |
| 43 | 12834 | 6773 | 10865 | 2094 |
| 42 | 12110 | 6110 | 10383 | 1980 |
| 41 | 11459 | 5533 | 9933 | 1886 |
| 40 | 10865 | 5026 | 9510 | 1805 |
| 39 | 10319 | 4576 | 9109 | 1735 |
| 38 | 9812 | 4173 | 8729 | 1674 |
| 37 | 9339 | 3810 | 8367 | 1619 |
| 36 | 8896 | 3481 | 8021 | 1571 |
| 35 | 8477 | 3183 | 7689 | 1527 |
| 34 | 8081 | 2910 | 7370 | 1487 |
| 33 | 7705 | 2661 | 7063 | 1450 |
| 32 | 7346 | 2433 | 6766 | 1417 |
| 31 | 7003 | 2223 | 6479 | 1386 |
| 30 | 6675 | 2029 | 6201 | 1358 |
| 29 | 6359 | 1850 | 5932 | 1331 |
| 28 | 6056 | 1686 | 5670 | 1307 |
| 27 | 5763 | 1533 | 5415 | 1284 |
| 26 | 5480 | 1392 | 5167 | 1263 |
| 25 | 5206 | 1261 | 4924 | 1243 |
| 24 | 4941 | 1140 | 4688 | 1224 |
| 23 | 4683 | 1028 | 4456 | 1207 |
| 22 | 4432 | 924·5 | 4230 | 1190 |
| 21 | 4188 | 828·4 | 4008 | 1175 |
| 20 | 3951 | 739·5 | 3791 | 1160 |
| 19 | 3719 | 657·3 | 3577 | 1146 |
| 18 | 3492 | 581·4 | 3368 | 1134 |
| 17 | 3270 | 511·4 | 3161 | 1121 |
| 16 | 3053 | 447·1 | 2958 | 1110 |

| $\gamma = 0{\cdot}20$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 15° | 2840 | 388·0 | 2758 | 1099 |
| 14 | 2631 | 334·0 | 2561 | 1089 |
| 13 | 2426 | 284·7 | 2366 | 1080 |
| 12 | 2224 | 240·0 | 2174 | 1071 |
| 11 | 2025 | 199·6 | 1984 | 1062 |
| 10 | 1830 | 163·3 | 1796 | 1054 |
| 9 | 1637 | 131·1 | 1610 | 1047 |
| 8 | 1447 | 102·7 | 1426 | 1040 |
| 7 | 1259 | 78·0 | 1244 | 1034 |
| 6 | 1074 | 56·9 | 1063 | 1028 |
| 5 | 891 | 39·2 | 883 | 1022 |
| 4 | 709 | 24·9 | 704 | 1017 |
| 3 | 530 | 13·9 | 527 | 1012 |
| 2 | 352 | 6·2 | 351 | 1008 |
| 1 | 175 | 1·5 | 175 | 1004 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 174 | 1·5 | 174 | 997 |
| 2 | 347 | 6·0 | 348 | 994 |
| 3 | 519 | 13·6 | 521 | 991 |
| 4 | 690 | 24·0 | 695 | 989 |
| 5 | 860 | 37·4 | 867 | 987 |
| 6 | 1030 | 53·7 | 1040 | 985 |
| 7 | 1199 | 73·0 | 1213 | 984 |
| 8 | 1368 | 95·2 | 1386 | 983 |
| 9 | 1536 | 120·4 | 1560 | 982 |
| 10 | 1704 | 148·6 | 1733 | 982 |
| 11 | 1872 | 179·7 | 1908 | 982 |
| 12 | 2041 | 213·9 | 2083 | 982 |
| 13 | 2209 | 251·2 | 2258 | 982 |
| 14 | 2377 | 291·7 | 2434 | 983 |
| 15 | 2546 | 335·4 | 2612 | 984 |
| 16 | 2715 | 382·3 | 2790 | 985 |
| 17 | 2885 | 432·6 | 2970 | 987 |
| 18 | 3055 | 486·3 | 3150 | 989 |
| 19 | 3226 | 543·4 | 3333 | 991 |
| 20 | 3398 | 604·4 | 3516 | 994 |
| 21 | 3571 | 669·0 | 3702 | 997 |
| 22 | 3745 | 737·5 | 3889 | 1000 |
| 23 | 3920 | 810·0 | 4078 | 1003 |
| 24 | 4096 | 886·7 | 4269 | 1007 |
| 25 | 4274 | 967·7 | 4463 | 1011 |
| 26 | 4453 | 1053 | 4659 | 1015 |
| 27 | 4634 | 1143 | 4857 | 1020 |
| 28 | 4816 | 1238 | 5059 | 1025 |
| 29 | 5001 | 1338 | 5263 | 1030 |
| 30 | 5187 | 1444 | 5470 | 1036 |

XVI. (*continued*).

$\gamma = 0{\cdot}20$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 31° | 5375 | 1555 | 5680 | 1042 |
| 32 | 5566 | 1671 | 5894 | 1048 |
| 33 | 5759 | 1794 | 6112 | 1055 |
| 34 | 5954 | 1924 | 6333 | 1062 |
| 35 | 6152 | 2060 | 6559 | 1069 |
| 36 | 6353 | 2203 | 6789 | 1077 |
| 37 | 6557 | 2354 | 7024 | 1085 |
| 38 | 6764 | 2513 | 7263 | 1093 |
| 39 | 6975 | 2680 | 7508 | 1102 |
| 40 | 7188 | 2856 | 7758 | 1111 |
| 41 | 7406 | 3042 | 8014 | 1121 |
| 42 | 7627 | 3238 | 8277 | 1131 |
| 43 | 7852 | 3444 | 8546 | 1141 |
| 44 | 8081 | 3662 | 8821 | 1152 |
| 45 | 8315 | 3891 | 9104 | 1163 |
| 46 | 8553 | 4134 | 9395 | 1174 |
| 47 | 8796 | 4390 | 9695 | 1186 |
| 48 | 9044 | 4660 | 10003 | 1198 |
| 49 | 9297 | 4947 | 10320 | 1211 |
| 50 | 9556 | 5250 | 10647 | 1224 |
| 51 | 9820 | 5570 | 10985 | 1237 |
| 52 | 10090 | 5910 | 11334 | 1251 |
| 53 | 10367 | 6270 | 11694 | 1266 |
| 54 | 10649 | 6652 | 12068 | 1280 |
| 55 | 10939 | 7058 | 12455 | 1295 |
| 56 | 11235 | 7489 | 12856 | 1310 |
| 57 | 11538 | 7948 | 13273 | 1326 |
| 58 | 11849 | 8435 | 13707 | 1342 |
| 59 | 12167 | 8955 | 14158 | 1358 |
| 60 | 12493 | 9508 | 14628 | 1375 |

$\gamma = 0{\cdot}22$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 45° | 15901 | 9575 | 12394 | 2867 |
| 44 | 14637 | 8332 | 11736 | 2537 |
| 43 | 13614 | 7361 | 11153 | 2315 |
| 42 | 12747 | 6566 | 10626 | 2150 |
| 41 | 11989 | 5895 | 10140 | 2021 |

$\gamma = 0{\cdot}22$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 40° | 11314 | 5318 | 9689 | 1916 |
| 39 | 10703 | 4814 | 9265 | 1828 |
| 38 | 10144 | 4369 | 8866 | 1753 |
| 37 | 9628 | 3973 | 8488 | 1688 |
| 36 | 9148 | 3618 | 8128 | 1630 |
| 35 | 8699 | 3298 | 7784 | 1579 |
| 34 | 8277 | 3007 | 7455 | 1533 |
| 33 | 7878 | 2743 | 7138 | 1491 |
| 32 | 7499 | 2502 | 6834 | 1454 |
| 31 | 7139 | 2282 | 6540 | 1419 |
| 30 | 6796 | 2079 | 6255 | 1387 |
| 29 | 6467 | 1893 | 5980 | 1358 |
| 28 | 6152 | 1722 | 5713 | 1331 |
| 27 | 5848 | 1564 | 5454 | 1306 |
| 26 | 5556 | 1418 | 5201 | 1283 |
| 25 | 5274 | 1284 | 4955 | 1261 |
| 24 | 5001 | 1159 | 4716 | 1241 |
| 23 | 4736 | 1044 | 4481 | 1222 |
| 22 | 4479 | 937·7 | 4252 | 1204 |
| 21 | 4230 | 839·4 | 4028 | 1187 |
| 20 | 3987 | 748·7 | 3808 | 1172 |

$\gamma = 0{\cdot}24$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 44° | 16126 | 9568 | 12208 | 3119 |
| 43 | 14682 | 8192 | 11517 | 2672 |
| 42 | 13566 | 7170 | 10919 | 2399 |
| 41 | 12644 | 6353 | 10383 | 2207 |
| 40 | 11851 | 5676 | 9894 | 2061 |
| 39 | 11152 | 5100 | 9441 | 1945 |
| 38 | 10525 | 4600 | 9018 | 1850 |
| 37 | 9954 | 4162 | 8621 | 1769 |
| 36 | 9430 | 3774 | 8244 | 1699 |
| 35 | 8944 | 3427 | 7887 | 1639 |
| 34 | 8491 | 3116 | 7545 | 1585 |
| 33 | 8066 | 2834 | 7219 | 1537 |
| 32 | 7665 | 2579 | 6905 | 1494 |
| 31 | 7285 | 2346 | 6603 | 1455 |

XVI. (*continued*).

$\gamma = 0{\cdot}24$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 30° | 6925 | 2134 | 6312 | 1420 |
| 29 | 6581 | 1939 | 6031 | 1387 |
| 28 | 6253 | 1761 | 5758 | 1357 |
| 27 | 5938 | 1597 | 5494 | 1330 |
| 26 | 5635 | 1446 | 5237 | 1304 |
| 25 | 5344 | 1307 | 4987 | 1280 |
| 24 | 5062 | 1180 | 4744 | 1258 |
| 23 | 4791 | 1061 | 4506 | 1238 |
| 22 | 4527 | 951·7 | 4274 | 1219 |
| 21 | 4272 | 851·1 | 4047 | 1201 |
| 20 | 4024 | 758·3 | 3825 | 1184 |

$\gamma = 0{\cdot}26$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 42° | 14725 | 8052 | 11297 | 2827 |
| 41 | 13504 | 6971 | 10681 | 2487 |
| 40 | 12524 | 6133 | 10137 | 2263 |
| 39 | 11696 | 5451 | 9645 | 2099 |
| 38 | 10974 | 4876 | 9191 | 1972 |
| 37 | 10331 | 4383 | 8769 | 1868 |
| 36 | 9751 | 3953 | 8373 | 1782 |
| 35 | 9219 | 3574 | 7999 | 1709 |
| 34 | 8729 | 3237 | 7644 | 1645 |
| 33 | 8272 | 2935 | 7305 | 1589 |
| 32 | 7845 | 2663 | 6982 | 1540 |
| 31 | 7444 | 2416 | 6671 | 1495 |
| 30 | 7064 | 2193 | 6372 | 1455 |
| 29 | 6704 | 1989 | 6084 | 1419 |
| 28 | 6361 | 1803 | 5806 | 1386 |
| 27 | 6033 | 1632 | 5536 | 1355 |
| 26 | 5719 | 1475 | 5275 | 1327 |
| 25 | 5418 | 1332 | 5021 | 1301 |
| 24 | 5128 | 1200 | 4773 | 1277 |
| 23 | 4848 | 1078 | 4532 | 1255 |
| 22 | 4578 | 966·0 | 4297 | 1234 |
| 21 | 4317 | 863·0 | 4068 | 1215 |
| 20 | 4063 | 768·2 | 3843 | 1196 |

$\gamma = 0{\cdot}28$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 41° | 14763 | 7911 | 11075 | 3003 |
| 40 | 13421 | 6763 | 10439 | 2579 |
| 39 | 12381 | 5905 | 9887 | 2318 |
| 38 | 11519 | 5219 | 9391 | 2134 |
| 37 | 10776 | 4649 | 8938 | 1995 |
| 36 | 10121 | 4164 | 8517 | 1884 |
| 35 | 9532 | 3743 | 8123 | 1793 |
| 34 | 8995 | 3375 | 7752 | 1716 |
| 33 | 8501 | 3048 | 7400 | 1649 |
| 32 | 8044 | 2756 | 7065 | 1591 |
| 31 | 7616 | 2494 | 6744 | 1541 |
| 30 | 7214 | 2257 | 6437 | 1495 |
| 29 | 6835 | 2043 | 6141 | 1453 |
| 28 | 6476 | 1847 | 5856 | 1416 |
| 27 | 6134 | 1669 | 5581 | 1383 |
| 26 | 5808 | 1507 | 5314 | 1352 |
| 25 | 5496 | 1358 | 5056 | 1323 |
| 24 | 5197 | 1221 | 4804 | 1297 |
| 23 | 4909 | 1096 | 4560 | 1273 |
| 22 | 4631 | 981·2 | 4322 | 1250 |
| 21 | 4363 | 875·6 | 4089 | 1229 |
| 20 | 4103 | 778·5 | 3862 | 1210 |

$\gamma = 0{\cdot}30$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 40° | 14791 | 7761 | 10848 | 3205 |
| 39 | 13312 | 6541 | 10190 | 2670 |
| 38 | 12213 | 5666 | 9631 | 2369 |
| 37 | 11320 | 4980 | 9133 | 2164 |
| 36 | 10560 | 4418 | 8680 | 2014 |
| 35 | 9894 | 3942 | 8262 | 1896 |
| 34 | 9298 | 3533 | 7870 | 1800 |
| 33 | 8758 | 3176 | 7502 | 1720 |
| 32 | 8263 | 2860 | 7154 | 1651 |
| 31 | 7805 | 2579 | 6822 | 1591 |

XVI. (*continued*).

| $\gamma = 0{\cdot}30$ | | | | | $\gamma = 0{\cdot}30$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (V) | $\phi$ | (x) | (y) | (T) | (V) |
| 30° | 7378 | 2327 | 6505 | 1539 | 16° | 2649 | 369·8 | 2755 | 962 |
| 29 | 6977 | 2101 | 6201 | 1492 | 17 | 2810 | 417·7 | 2930 | 962 |
| 28 | 6600 | 1896 | 5909 | 1450 | 18 | 2972 | 468·7 | 3106 | 963 |
| 27 | 6242 | 1710 | 5628 | 1412 | 19 | 3134 | 522·8 | 3284 | 964 |
| 26 | 5903 | 1540 | 5356 | 1378 | 20 | 3296 | 580·3 | 3462 | 965 |
| 25 | 5579 | 1386 | 5092 | 1347 | 21 | 3459 | 641·1 | 3642 | 966 |
| 24 | 5269 | 1244 | 4837 | 1318 | 22 | 3622 | 705·4 | 3824 | 968 |
| 23 | 4972 | 1115 | 4588 | 1292 | 23 | 3786 | 773·3 | 4007 | 970 |
| 22 | 4686 | 997·0 | 4347 | 1267 | 24 | 3950 | 844·9 | 4191 | 972 |
| 21 | 4411 | 888·5 | 4111 | 1245 | 25 | 4116 | 920·3 | 4378 | 975 |
| 20 | 4145 | 789·2 | 3881 | 1224 | 26 | 4282 | 999·6 | 4567 | 978 |
| 19 | 3888 | 698·1 | 3656 | 1204 | 27 | 4449 | 1083 | 4758 | 981 |
| 18 | 3639 | 614·7 | 3437 | 1186 | 28 | 4618 | 1171 | 4951 | 984 |
| 17 | 3397 | 538·5 | 3221 | 1169 | 29 | 4788 | 1263 | 5147 | 988 |
| 16 | 3162 | 468·8 | 3010 | 1153 | 30 | 4959 | 1360 | 5346 | 992 |
| 15 | 2933 | 405·3 | 2802 | 1138 | 31 | 5131 | 1461 | 5547 | 996 |
| 14 | 2710 | 347·6 | 2599 | 1124 | 32 | 5305 | 1568 | 5751 | 1001 |
| 13 | 2492 | 295·2 | 2398 | 1111 | 33 | 5481 | 1680 | 5959 | 1006 |
| 12 | 2279 | 248·0 | 2201 | 1099 | 34 | 5658 | 1797 | 6170 | 1011 |
| 11 | 2071 | 205·6 | 2006 | 1087 | 35 | 5837 | 1921 | 6385 | 1016 |
| 10 | 1866 | 167·7 | 1814 | 1076 | 36 | 6019 | 2050 | 6603 | 1022 |
| 9 | 1666 | 134·2 | 1624 | 1066 | 37 | 6202 | 2186 | 6826 | 1028 |
| 8 | 1469 | 104·8 | 1437 | 1057 | 38 | 6388 | 2328 | 7053 | 1035 |
| 7 | 1276 | 79·4 | 1252 | 1048 | 39 | 6576 | 2477 | 7284 | 1041 |
| 6 | 1086 | 57·7 | 1068 | 1040 | 40 | 6766 | 2634 | 7520 | 1048 |
| 5 | 899 | 39·7 | 887 | 1032 | 41 | 6959 | 2799 | 7762 | 1055 |
| 4 | 715 | 25·2 | 707 | 1024 | 42 | 7155 | 2973 | 8009 | 1063 |
| 3 | 533 | 14·0 | 528 | 1018 | 43 | 7353 | 3155 | 8261 | 1071 |
| 2 | 353 | 6·2 | 351 | 1011 | 44 | 7555 | 3346 | 8520 | 1079 |
| 1 | 176 | 1·5 | 175 | 1005 | 45 | 7760 | 3547 | 8785 | 1087 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 174 | 1·5 | 174 | 995 | 46 | 7968 | 3759 | 9057 | 1096 |
| 2 | 346 | 6·0 | 347 | 990 | 47 | 8179 | 3982 | 9336 | 1105 |
| 3 | 516 | 13·5 | 520 | 986 | 48 | 8394 | 4216 | 9622 | 1115 |
| 4 | 685 | 23·8 | 692 | 982 | 49 | 8613 | 4464 | 9917 | 1124 |
| 5 | 853 | 37·0 | 864 | 979 | 50 | 8836 | 4724 | 10221 | 1134 |
| 6 | 1020 | 53·0 | 1035 | 976 | 51 | 9062 | 4999 | 10533 | 1144 |
| 7 | 1185 | 71·9 | 1206 | 973 | 52 | 9293 | 5289 | 10856 | 1155 |
| 8 | 1350 | 93·6 | 1377 | 970 | 53 | 9528 | 5595 | 11189 | 1166 |
| 9 | 1514 | 118·1 | 1548 | 968 | 54 | 9767 | 5919 | 11532 | 1177 |
| 10 | 1677 | 145·4 | 1719 | 966 | 55 | 10011 | 6261 | 11888 | 1188 |
| 11 | 1840 | 175·6 | 1891 | 965 | 56 | 10260 | 6623 | 12256 | 1200 |
| 12 | 2002 | 208·6 | 2063 | 964 | 57 | 10514 | 7006 | 12637 | 1211 |
| 13 | 2164 | 244·5 | 2235 | 963 | 58 | 10772 | 7413 | 13032 | 1223 |
| 14 | 2326 | 283·3 | 2408 | 962 | 59 | 11036 | 7843 | 13443 | 1236 |
| 15 | 2487 | 325·1 | 2581 | 962 | 60 | 11305 | 8300 | 13870 | 1248 |

XVI. (*continued*).

| $\gamma = 0{\cdot}35$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 37° | 13690 | 6512 | 9864 | 3216 |
| 36 | 12225 | 5427 | 9236 | 2638 |
| 35 | 11159 | 4666 | 8707 | 2326 |
| 34 | 10301 | 4076 | 8237 | 2119 |
| 33 | 9574 | 3595 | 7810 | 1968 |
| 32 | 8939 | 3190 | 7415 | 1851 |
| 31 | 8372 | 2842 | 7046 | 1756 |
| 30 | 7858 | 2539 | 6699 | 1677 |
| 29 | 7387 | 2273 | 6369 | 1610 |
| 28 | 6952 | 2036 | 6056 | 1551 |
| 27 | 6546 | 1825 | 5756 | 1500 |
| 26 | 6165 | 1635 | 5467 | 1455 |
| 25 | 5806 | 1463 | 5190 | 1414 |
| 24 | 5466 | 1308 | 4922 | 1378 |
| 23 | 5143 | 1168 | 4663 | 1345 |
| 22 | 4834 | 1040 | 4412 | 1314 |
| 21 | 4539 | 923·8 | 4168 | 1287 |
| 20 | 4256 | 817·9 | 3931 | 1261 |

| $\gamma = 0{\cdot}40$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 34° | 12157 | 5144 | 8813 | 2958 |
| 33 | 10889 | 4304 | 8250 | 2480 |
| 32 | 9938 | 3697 | 7767 | 2207 |
| 31 | 9161 | 3221 | 7335 | 2022 |
| 30 | 8498 | 2830 | 6940 | 1884 |
| 29 | 7914 | 2500 | 6574 | 1776 |
| 28 | 7391 | 2215 | 6230 | 1689 |
| 27 | 6916 | 1968 | 5905 | 1615 |
| 26 | 6478 | 1750 | 5596 | 1552 |
| 25 | 6073 | 1556 | 5302 | 1498 |
| 24 | 5694 | 1383 | 5019 | 1450 |
| 23 | 5338 | 1229 | 4747 | 1407 |
| 22 | 5002 | 1089 | 4485 | 1369 |
| 21 | 4683 | 963·7 | 4231 | 1335 |

| $\gamma = 0{\cdot}40$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 20° | 4379 | 850·1 | 3986 | 1304 |
| 19 | 4089 | 747·4 | 3747 | 1275 |
| 18 | 3811 | 654·3 | 3515 | 1249 |
| 17 | 3544 | 570·1 | 3288 | 1225 |
| 16 | 3287 | 493·9 | 3067 | 1203 |
| 15 | 3038 | 425·0 | 2851 | 1183 |
| 14 | 2798 | 362·9 | 2640 | 1164 |
| 13 | 2565 | 307·0 | 2432 | 1146 |
| 12 | 2339 | 256·9 | 2229 | 1130 |
| 11 | 2120 | 212·2 | 2029 | 1114 |
| 10 | 1906 | 172·5 | 1833 | 1100 |
| 9 | 1697 | 137·6 | 1639 | 1087 |
| 8 | 1493 | 107·1 | 1448 | 1074 |
| 7 | 1294 | 80·9 | 1260 | 1063 |
| 6 | 1099 | 58·6 | 1075 | 1052 |
| 5 | 908 | 40·2 | 891 | 1042 |
| 4 | 720 | 25·4 | 709 | 1032 |
| 3 | 536 | 14·1 | 530 | 1023 |
| 2 | 354 | 6·2 | 352 | 1015 |
| 1 | 176 | 1·5 | 175 | 1007 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 173 | 1·5 | 174 | 993 |
| 2 | 344 | 6·0 | 347 | 987 |
| 3 | 514 | 13·4 | 519 | 981 |
| 4 | 681 | 23·6 | 690 | 976 |
| 5 | 846 | 36·6 | 860 | 971 |
| 6 | 1010 | 52·4 | 1030 | 966 |
| 7 | 1172 | 70·9 | 1200 | 962 |
| 8 | 1333 | 92·0 | 1369 | 958 |
| 9 | 1493 | 115·9 | 1537 | 955 |
| 10 | 1651 | 142·5 | 1706 | 952 |
| 11 | 1809 | 171·7 | 1875 | 949 |
| 12 | 1966 | 203·6 | 2044 | 947 |
| 13 | 2122 | 238·2 | 2213 | 945 |
| 14 | 2277 | 275·5 | 2382 | 943 |
| 15 | 2432 | 315·6 | 2552 | 942 |
| 16 | 2587 | 358·5 | 2722 | 940 |
| 17 | 2741 | 404·2 | 2894 | 940 |
| 18 | 2895 | 452·7 | 3065 | 939 |
| 19 | 3049 | 504·2 | 3238 | 939 |
| 20 | 3203 | 558·7 | 3412 | 939 |

XVI. (*continued*).

| $\gamma = 0{\cdot}40$ | | | | | $\gamma = 0{\cdot}45$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) | $\phi$ | (x) | (y) | (T) | (v) |
| 21° | 3357 | 616·2 | 3587 | 939 | 32° | 11924 | 4776 | 8344 | 3276 |
| 22 | 3511 | 676·9 | 3763 | 940 | 31 | 10463 | 3879 | 7754 | 2592 |
| 23 | 3665 | 740·8 | 3941 | 941 | | | | | |
| 24 | 3820 | 808·1 | 4120 | 942 | 30 | 9448 | 3281 | 7265 | 2257 |
| 25 | 3975 | 878·7 | 4301 | 943 | 29 | 8646 | 2826 | 6836 | 2044 |
| | | | | | 28 | 7972 | 2460 | 6445 | 1892 |
| 26 | 4130 | 953·0 | 4483 | 945 | 27 | 7387 | 2155 | 6085 | 1775 |
| 27 | 4287 | 1031 | 4668 | 947 | 26 | 6866 | 1895 | 5748 | 1682 |
| 28 | 4444 | 1113 | 4855 | 949 | | | | | |
| 29 | 4601 | 1198 | 5043 | 952 | 25 | 6395 | 1670 | 5430 | 1605 |
| 30 | 4760 | 1288 | 5234 | 955 | 24 | 5964 | 1474 | 5129 | 1540 |
| | | | | | 23 | 5565 | 1300 | 4841 | 1484 |
| 31 | 4919 | 1382 | 5428 | 958 | 22 | 5194 | 1147 | 4566 | 1435 |
| 32 | 5080 | 1480 | 5625 | 961 | 21 | 4845 | 1009 | 4301 | 1391 |
| 33 | 5242 | 1583 | 5824 | 965 | 20 | 4517 | 886·5 | 4045 | 1353 |
| 34 | 5405 | 1691 | 6026 | 969 | | | | | |
| 35 | 5569 | 1804 | 6232 | 973 | | | | | |
| 36 | 5735 | 1923 | 6441 | 977 | | | | | |
| 37 | 5902 | 2046 | 6653 | 982 | | | | | |
| 38 | 6072 | 2176 | 6870 | 987 | | | | | |
| 39 | 6242 | 2312 | 7090 | 992 | | | | | |
| 40 | 6415 | 2454 | 7315 | 997 | | | | | |
| 41 | 6589 | 2603 | 7545 | 1003 | | | | | |
| 42 | 6766 | 2760 | 7779 | 1009 | | | | | |
| 43 | 6945 | 2923 | 8019 | 1015 | | | | | |
| 44 | 7126 | 3095 | 8264 | 1022 | | | | | |
| 45 | 7309 | 3275 | 8515 | 1029 | | | | | |
| 46 | 7495 | 3465 | 8772 | 1036 | | | | | |
| 47 | 7684 | 3663 | 9035 | 1043 | | | | | |
| 48 | 7875 | 3872 | 9306 | 1050 | | | | | |
| 49 | 8069 | 4091 | 9583 | 1058 | | | | | |
| 50 | 8265 | 4322 | 9869 | 1066 | | | | | |
| 51 | 8465 | 4564 | 10162 | 1074 | | | | | |
| 52 | 8668 | 4820 | 10465 | 1083 | | | | | |
| 53 | 8875 | 5088 | 10777 | 1092 | | | | | |
| 54 | 9084 | 5372 | 11098 | 1101 | | | | | |
| 55 | 9298 | 5671 | 11430 | 1110 | | | | | |
| 56 | 9514 | 5986 | 11774 | 1119 | | | | | |
| 57 | 9735 | 6319 | 12129 | 1128 | | | | | |
| 58 | 9959 | 6671 | 12497 | 1138 | | | | | |
| 59 | 10187 | 7043 | 12879 | 1148 | | | | | |
| 60 | 10419 | 7437 | 13275 | 1158 | | | | | |

| $\gamma = 0{\cdot}50$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 29° | 9841 | 3387 | 7211 | 2617 |
| 28 | 8820 | 2832 | 6731 | 2252 |
| 27 | 8026 | 2419 | 6311 | 2028 |
| 26 | 7364 | 2089 | 5932 | 1871 |
| 25 | 6794 | 1816 | 5582 | 1752 |
| 24 | 6288 | 1586 | 5255 | 1658 |
| 23 | 5831 | 1387 | 4947 | 1580 |
| 22 | 5414 | 1214 | 4655 | 1515 |
| 21 | 5028 | 1062 | 4376 | 1459 |
| 20 | 4669 | 927·8 | 4109 | 1410 |
| 19 | 4333 | 808·7 | 3852 | 1367 |
| 18 | 4016 | 702·6 | 3604 | 1329 |
| 17 | 3716 | 607·9 | 3364 | 1295 |
| 16 | 3430 | 523·4 | 3131 | 1264 |
| 15 | 3158 | 447·8 | 2905 | 1235 |
| 14 | 2897 | 380·3 | 2685 | 1210 |
| 13 | 2647 | 320·2 | 2470 | 1186 |
| 12 | 2406 | 266·7 | 2260 | 1165 |
| 11 | 2173 | 219·4 | 2054 | 1145 |

## XVI. (*continued*).

| $\gamma = 0{\cdot}50$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 10° | 1948 | 177·6 | 1852 | 1126 |
| 9 | 1730 | 141·1 | 1655 | 1109 |
| 8 | 1518 | 109·5 | 1460 | 1093 |
| 7 | 1312 | 82·4 | 1269 | 1079 |
| 6 | 1112 | 59·6 | 1081 | 1065 |
| 5 | 916 | 40·7 | 895 | 1052 |
| 4 | 725 | 25·7 | 712 | 1040 |
| 3 | 539 | 14·2 | 531 | 1029 |
| 2 | 356 | 6·3 | 352 | 1019 |
| 1 | 176 | 1·5 | 175 | 1009 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 173 | 1·5 | 174 | 992 |
| 2 | 343 | 6·0 | 346 | 984 |
| 3 | 511 | 13·3 | 517 | 976 |
| 4 | 676 | 23·4 | 688 | 970 |
| 5 | 839 | 36·2 | 857 | 963 |
| 6 | 1000 | 51·7 | 1025 | 957 |
| 7 | 1159 | 69·8 | 1193 | 952 |
| 8 | 1317 | 90·5 | 1360 | 947 |
| 9 | 1472 | 113·8 | 1527 | 943 |
| 10 | 1627 | 139·7 | 1693 | 938 |
| 11 | 1780 | 168·0 | 1859 | 935 |
| 12 | 1932 | 198·9 | 2026 | 931 |
| 13 | 2082 | 232·3 | 2192 | 928 |
| 14 | 2232 | 268·3 | 2358 | 925 |
| 15 | 2381 | 306·9 | 2525 | 923 |
| 16 | 2530 | 348·0 | 2692 | 921 |
| 17 | 2677 | 391·8 | 2859 | 919 |
| 18 | 2825 | 438·2 | 3027 | 918 |
| 19 | 2971 | 487·3 | 3196 | 917 |
| 20 | 3118 | 539·1 | 3366 | 916 |
| 21 | 3264 | 593·8 | 3536 | 915 |
| 22 | 3410 | 651·3 | 3708 | 915 |
| 23 | 3556 | 711·8 | 3881 | 915 |
| 24 | 3702 | 775·4 | 4055 | 915 |
| 25 | 3848 | 842·0 | 4230 | 916 |
| 26 | 3995 | 911·8 | 4407 | 916 |
| 27 | 4142 | 985·0 | 4586 | 918 |
| 28 | 4289 | 1062 | 4767 | 919 |
| 29 | 4436 | 1142 | 4949 | 920 |
| 30 | 4585 | 1226 | 5134 | 922 |

| $\gamma = 0{\cdot}50$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 31° | 4733 | 1313 | 5321 | 925 |
| 32 | 4883 | 1405 | 5511 | 927 |
| 33 | 5033 | 1501 | 5703 | 930 |
| 34 | 5184 | 1601 | 5898 | 932 |
| 35 | 5337 | 1705 | 6095 | 936 |
| 36 | 5490 | 1815 | 6296 | 939 |
| 37 | 5644 | 1929 | 6501 | 943 |
| 38 | 5800 | 2049 | 6708 | 947 |
| 39 | 5957 | 2173 | 6920 | 951 |
| 40 | 6116 | 2304 | 7136 | 955 |
| 41 | 6276 | 2441 | 7355 | 960 |
| 42 | 6437 | 2584 | 7579 | 965 |
| 43 | 6600 | 2733 | 7808 | 970 |
| 44 | 6765 | 2890 | 8042 | 975 |
| 45 | 6932 | 3054 | 8282 | 981 |
| 46 | 7101 | 3226 | 8526 | 986 |
| 47 | 7272 | 3406 | 8777 | 992 |
| 48 | 7445 | 3594 | 9035 | 999 |
| 49 | 7620 | 3792 | 9298 | 1005 |
| 50 | 7798 | 4000 | 9570 | 1012 |
| 51 | 7978 | 4219 | 9848 | 1019 |
| 52 | 8160 | 4448 | 10135 | 1026 |
| 53 | 8345 | 4689 | 10430 | 1033 |
| 54 | 8533 | 4943 | 10734 | 1041 |
| 55 | 8723 | 5210 | 11048 | 1048 |
| 56 | 8916 | 5491 | 11373 | 1056 |
| 57 | 9112 | 5787 | 11708 | 1064 |
| 58 | 9312 | 6100 | 12055 | 1072 |
| 59 | 9514 | 6430 | 12414 | 1081 |
| 60 | 9719 | 6779 | 12788 | 1089 |

| $\gamma = 0{\cdot}60$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 26° | 9334 | 2908 | 6533 | 2970 |
| 25 | 8120 | 2327 | 6024 | 2379 |
| 24 | 7261 | 1936 | 5599 | 2081 |
| 23 | 6577 | 1638 | 5222 | 1890 |
| 22 | 6000 | 1399 | 4879 | 1752 |
| 21 | 5497 | 1200 | 4560 | 1647 |

XVI. (*continued*).

| $\gamma = 0{\cdot}60$ | | | | | $\gamma = 0{\cdot}60$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 20° | 5048 | 1033 | 4261 | 1563 | 21° | 3179 | 573·5 | 3489 | 893 |
| 19 | 4642 | 888·5 | 3979 | 1493 | 22 | 3318 | 628·3 | 3656 | 892 |
| 18 | 4268 | 763·5 | 3710 | 1434 | 23 | 3457 | 685·8 | 3824 | 891 |
| 17 | 3923 | 654·4 | 3452 | 1383 | 24 | 3595 | 746·0 | 3994 | 891 |
| 16 | 3600 | 558·8 | 3204 | 1338 | 25 | 3734 | 809·2 | 4165 | 891 |
| 15 | 3296 | 474·6 | 2966 | 1299 | 26 | 3872 | 875·2 | 4337 | 891 |
| 14 | 3010 | 400·5 | 2735 | 1264 | 27 | 4011 | 944·3 | 4511 | 891 |
| 13 | 2738 | 335·2 | 2510 | 1233 | 28 | 4150 | 1017 | 4686 | 892 |
| 12 | 2479 | 277·7 | 2293 | 1204 | 29 | 4289 | 1092 | 4864 | 893 |
| 11 | 2231 | 227·3 | 2081 | 1179 | 30 | 4428 | 1171 | 5043 | 894 |
| 10 | 1993 | 183·3 | 1874 | 1155 | 31 | 4568 | 1253 | 5224 | 895 |
| 9 | 1765 | 145·0 | 1671 | 1134 | 32 | 4708 | 1339 | 5408 | 897 |
| 8 | 1545 | 112·1 | 1473 | 1114 | 33 | 4849 | 1429 | 5593 | 899 |
| 7 | 1332 | 84·0 | 1278 | 1096 | 34 | 4990 | 1522 | 5782 | 901 |
| 6 | 1126 | 60·5 | 1087 | 1078 | 35 | 5132 | 1620 | 5973 | 904 |
| 5 | 925 | 41·3 | 900 | 1063 | 36 | 5275 | 1722 | 6167 | 906 |
| 4 | 731 | 25·9 | 715 | 1049 | 37 | 5419 | 1828 | 6364 | 909 |
| 3 | 542 | 14·4 | 533 | 1035 | 38 | 5564 | 1939 | 6564 | 912 |
| 2 | 357 | 6·3 | 353 | 1023 | 39 | 5709 | 2055 | 6768 | 916 |
| 1 | 176 | 1·6 | 176 | 1011 | 40 | 5856 | 2176 | 6976 | 919 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 173 | 1·5 | 174 | 990 | 41 | 6004 | 2303 | 7187 | 923 |
| 2 | 342 | 5·9 | 346 | 981 | 42 | 6154 | 2435 | 7402 | 927 |
| 3 | 508 | 13·2 | 516 | 972 | 43 | 6304 | 2573 | 7622 | 931 |
| 4 | 672 | 23·2 | 685 | 964 | 44 | 6456 | 2717 | 7847 | 936 |
| 5 | 833 | 35·8 | 853 | 956 | 45 | 6610 | 2868 | 8077 | 941 |
| 6 | 991 | 51·1 | 1020 | 949 | 46 | 6765 | 3026 | 8311 | 945 |
| 7 | 1147 | 68·9 | 1187 | 942 | 47 | 6922 | 3192 | 8552 | 951 |
| 8 | 1301 | 89·1 | 1352 | 936 | 48 | 7081 | 3365 | 8798 | 956 |
| 9 | 1453 | 111·8 | 1517 | 931 | 49 | 7241 | 3546 | 9051 | 962 |
| 10 | 1603 | 137·0 | 1681 | 926 | 50 | 7403 | 3736 | 9310 | 967 |
| 11 | 1752 | 164·6 | 1845 | 921 | 51 | 7568 | 3935 | 9576 | 973 |
| 12 | 1899 | 194·5 | 2008 | 916 | 52 | 7734 | 4144 | 9850 | 979 |
| 13 | 2045 | 226·9 | 2172 | 913 | 53 | 7902 | 4364 | 10131 | 986 |
| 14 | 2190 | 261·6 | 2335 | 909 | 54 | 8073 | 4595 | 10422 | 992 |
| 15 | 2334 | 298·8 | 2499 | 906 | 55 | 8246 | 4837 | 10721 | 999 |
| 16 | 2476 | 338·3 | 2663 | 903 | 56 | 8421 | 5092 | 11030 | 1006 |
| 17 | 2618 | 380·3 | 2827 | 900 | 57 | 8599 | 5361 | 11349 | 1013 |
| 18 | 2759 | 424·8 | 2991 | 898 | 58 | 8779 | 5644 | 11679 | 1020 |
| 19 | 2900 | 471·8 | 3156 | 896 | 59 | 8962 | 5942 | 12021 | 1027 |
| 20 | 3040 | 521·4 | 3322 | 894 | 60 | 9147 | 6257 | 12375 | 1034 |

XVI. (*continued*).

| $\gamma = 0{\cdot}70$ | | | | | $\gamma = 0{\cdot}70$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) | $\phi$ | (x) | (y) | (T) | (v) |
| 23° | 8132 | 2201 | 5692 | 2856 | 21° | 3101 | 555·0 | 3444 | 873 |
| 22 | 7012 | 1736 | 5215 | 2283 | 22 | 3233 | 607·3 | 3608 | 872 |
| 21 | 6221 | 1424 | 4815 | 1997 | 23 | 3366 | 662·1 | 3772 | 870 |
| | | | | | 24 | 3498 | 719·5 | 3938 | 869 |
| 20 | 5590 | 1188 | 4461 | 1814 | 25 | 3630 | 779·6 | 4104 | 869 |
| 19 | 5059 | 1000 | 4138 | 1683 | | | | | |
| 18 | 4595 | 844·6 | 3838 | 1582 | 26 | 3761 | 842·3 | 4272 | 868 |
| 17 | 4180 | 714·0 | 3556 | 1501 | 27 | 3893 | 907·9 | 4442 | 868 |
| 16 | 3805 | 602·7 | 3289 | 1435 | 28 | 4024 | 976·3 | 4612 | 868 |
| | | | | | 29 | 4156 | 1048 | 4785 | 868 |
| 15 | 3460 | 507·0 | 3035 | 1378 | 30 | 4287 | 1122 | 4959 | 869 |
| 14 | 3140 | 424·2 | 2791 | 1330 | | | | | |
| 13 | 2841 | 352·5 | 2556 | 1288 | 31 | 4419 | 1200 | 5135 | 870 |
| 12 | 2561 | 290·2 | 2329 | 1250 | 32 | 4551 | 1281 | 5313 | 871 |
| 11 | 2295 | 236·2 | 2109 | 1217 | 33 | 4684 | 1365 | 5494 | 872 |
| | | | | | 34 | 4817 | 1453 | 5676 | 874 |
| 10 | 2043 | 189·5 | 1896 | 1187 | 35 | 4950 | 1545 | 5861 | 876 |
| 9 | 1803 | 149·2 | 1689 | 1160 | | | | | |
| 8 | 1573 | 114·8 | 1486 | 1136 | 36 | 5085 | 1641 | 6049 | 878 |
| 7 | 1352 | 85·8 | 1288 | 1113 | 37 | 5219 | 1741 | 6240 | 880 |
| 6 | 1140 | 61·6 | 1094 | 1093 | 38 | 5355 | 1845 | 6434 | 882 |
| | | | | | 39 | 5491 | 1953 | 6631 | 885 |
| 5 | 935 | 41·8 | 904 | 1074 | 40 | 5628 | 2066 | 6832 | 888 |
| 4 | 737 | 26·2 | 718 | 1057 | | | | | |
| 3 | 545 | 14·5 | 534 | 1041 | 41 | 5766 | 2184 | 7036 | 891 |
| 2 | 358 | 6·3 | 354 | 1026 | 42 | 5906 | 2307 | 7244 | 895 |
| 1 | 177 | 1·6 | 176 | 1013 | 43 | 6046 | 2436 | 7456 | 898 |
| 0 | 0 | 0 | 0 | 1000 | 44 | 6187 | 2570 | 7673 | 902 |
| 1 | 173 | 1·5 | 174 | 988 | 45 | 6331 | 2710 | 7894 | 906 |
| 2 | 341 | 5·9 | 345 | 977 | | | | | |
| 3 | 506 | 13·1 | 515 | 967 | 46 | 6474 | 2857 | 8120 | 910 |
| 4 | 668 | 23·0 | 683 | 958 | 47 | 6620 | 3010 | 8352 | 915 |
| 5 | 826 | 35·5 | 850 | 949 | 48 | 6766 | 3170 | 8589 | 920 |
| | | | | | 49 | 6915 | 3338 | 8832 | 925 |
| 6 | 982 | 50·5 | 1016 | 941 | 50 | 7065 | 3514 | 9081 | 930 |
| 7 | 1135 | 67·9 | 1180 | 933 | | | | | |
| 8 | 1286 | 87·8 | 1344 | 926 | 51 | 7216 | 3698 | 9337 | 935 |
| 9 | 1434 | 110·0 | 1507 | 919 | 52 | 7370 | 3891 | 9599 | 940 |
| 10 | 1581 | 134·5 | 1669 | 913 | 53 | 7525 | 4093 | 9870 | 946 |
| | | | | | 54 | 7682 | 4305 | 10148 | 952 |
| 11 | 1726 | 161·3 | 1831 | 908 | 55 | 7841 | 4528 | 10435 | 957 |
| 12 | 1869 | 190·4 | 1992 | 903 | | | | | |
| 13 | 2010 | 221·7 | 2153 | 898 | 56 | 8002 | 4762 | 10731 | 963 |
| 14 | 2150 | 255·4 | 2313 | 894 | 57 | 8165 | 5009 | 11037 | 970 |
| 15 | 2289 | 291·2 | 2474 | 890 | 58 | 8330 | 5268 | 11353 | 976 |
| | | | | | 59 | 8498 | 5541 | 11680 | 982 |
| 16 | 2426 | 329·4 | 2635 | 886 | 60 | 8667 | 5829 | 12019 | 989 |
| 17 | 2563 | 369·8 | 2796 | 883 | | | | | |
| 18 | 2699 | 412·6 | 2957 | 880 | | | | | |
| 19 | 2833 | 457·6 | 3119 | 877 | | | | | |
| 20 | 2967 | 505·1 | 3281 | 875 | | | | | |

XVI. (*continued*).

| $\gamma = 0{\cdot}80$ | | | | | $\gamma = 0{\cdot}80$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 20° | 6536 | 1476 | 4764 | 2393 | 21° | 3028 | 538·0 | 3402 | 855 |
| 19 | 5695 | 1178 | 4358 | 2032 | 22 | 3155 | 588·1 | 3562 | 853 |
| 18 | 5051 | 962·6 | 4004 | 1820 | 23 | 3282 | 640·6 | 3723 | 851 |
| 17 | 4521 | 795·0 | 3685 | 1675 | 24 | 3408 | 695·4 | 3885 | 850 |
| 16 | 4063 | 659·5 | 3391 | 1567 | 25 | 3534 | 752·7 | 4048 | 848 |
| 15 | 3659 | 547·2 | 3115 | 1481 | 26 | 3659 | 812·6 | 4212 | 847 |
| 14 | 3294 | 452·9 | 2854 | 1412 | 27 | 3785 | 875·0 | 4377 | 847 |
| 13 | 2961 | 372·8 | 2606 | 1353 | 28 | 3910 | 940·1 | 4544 | 846 |
| 12 | 2653 | 304·5 | 2369 | 1304 | 29 | 4035 | 1008 | 4712 | 846 |
| 11 | 2366 | 246·2 | 2141 | 1261 | 30 | 4160 | 1079 | 4882 | 846 |
| 10 | 2097 | 196·3 | 1920 | 1223 | 31 | 4285 | 1152 | 5053 | 847 |
| 9 | 1844 | 153·8 | 1707 | 1190 | 32 | 4410 | 1229 | 5226 | 847 |
| 8 | 1603 | 117·8 | 1500 | 1160 | 33 | 4535 | 1309 | 5402 | 848 |
| 7 | 1374 | 87·6 | 1298 | 1133 | 34 | 4661 | 1392 | 5579 | 849 |
| 6 | 1155 | 62·6 | 1101 | 1108 | 35 | 4787 | 1479 | 5759 | 851 |
| 5 | 945 | 42·4 | 909 | 1086 | 36 | 4914 | 1569 | 5942 | 852 |
| 4 | 743 | 26·5 | 721 | 1066 | 37 | 5041 | 1663 | 6127 | 854 |
| 3 | 548 | 14·6 | 536 | 1047 | 38 | 5168 | 1761 | 6315 | 856 |
| 2 | 360 | 6·3 | 354 | 1030 | 39 | 5297 | 1863 | 6507 | 858 |
| 1 | 177 | 1·6 | 176 | 1015 | 40 | 5426 | 1970 | 6701 | 861 |
| 0 | 0 | 0 | 0 | 1000 | | | | | |
| 1 | 172 | 1·5 | 173 | 987 | 41 | 5555 | 2080 | 6899 | 864 |
| 2 | 340 | 5·9 | 345 | 974 | 42 | 5686 | 2196 | 7101 | 867 |
| 3 | 504 | 13·0 | 514 | 963 | 43 | 5818 | 2316 | 7306 | 870 |
| 4 | 663 | 22·8 | 681 | 952 | 44 | 5950 | 2442 | 7516 | 873 |
| 5 | 820 | 35·1 | 847 | 942 | 45 | 6084 | 2573 | 7730 | 877 |
| 6 | 973 | 49·9 | 1011 | 933 | 46 | 6218 | 2710 | 7948 | 880 |
| 7 | 1124 | 67·0 | 1174 | 924 | 47 | 6354 | 2854 | 8172 | 884 |
| 8 | 1271 | 86·4 | 1336 | 916 | 48 | 6491 | 3003 | 8401 | 888 |
| 9 | 1417 | 108·2 | 1497 | 909 | 49 | 6630 | 3160 | 8636 | 893 |
| 10 | 1560 | 132·1 | 1657 | 902 | 50 | 6769 | 3323 | 8876 | 897 |
| 11 | 1701 | 158·2 | 1817 | 896 | 51 | 6911 | 3495 | 9123 | 902 |
| 12 | 1840 | 186·5 | 1976 | 890 | 52 | 7053 | 3674 | 9377 | 907 |
| 13 | 1977 | 216·9 | 2134 | 884 | 53 | 7198 | 3862 | 9637 | 912 |
| 14 | 2113 | 249·5 | 2293 | 879 | 54 | 7343 | 4059 | 9906 | 917 |
| 15 | 2247 | 284·2 | 2451 | 875 | 55 | 7490 | 4266 | 10182 | 922 |
| 16 | 2380 | 321·0 | 2609 | 870 | 56 | 7640 | 4483 | 10467 | 928 |
| 17 | 2511 | 360·0 | 2767 | 867 | 57 | 7791 | 4712 | 10761 | 933 |
| 18 | 2642 | 401·2 | 2925 | 863 | 58 | 7944 | 4952 | 11065 | 939 |
| 19 | 2771 | 444·5 | 3084 | 860 | 59 | 8099 | 5204 | 11380 | 945 |
| 20 | 2900 | 490·1 | 3243 | 857 | 60 | 8256 | 5471 | 11706 | 951 |

## XVI. (*continued*).

| $\gamma = 0{\cdot}90$ | | | | | $\gamma = 0{\cdot}90$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) | $\phi$ | (x) | (y) | (T) | (v) |
| 18° | 5812 | 1169 | 4247 | 2331 | 21° | 2961 | 522·3 | 3363 | 838 |
| 17 | 5016 | 917·9 | 3857 | 1973 | 22 | 3083 | 570·4 | 3520 | 836 |
| 16 | 4410 | 738·3 | 3518 | 1766 | 23 | 3204 | 620·8 | 3677 | 834 |
| | | | | | 24 | 3325 | 673·4 | 3836 | 832 |
| 15 | 3911 | 599·7 | 3211 | 1624 | 25 | 3446 | 728·3 | 3995 | 830 |
| 14 | 3482 | 488·5 | 2929 | 1518 | | | | | |
| 13 | 3102 | 397·2 | 2664 | 1435 | 26 | 3566 | 785·5 | 4156 | 829 |
| 12 | 2759 | 321·2 | 2413 | 1368 | 27 | 3685 | 845·2 | 4317 | 828 |
| 11 | 2446 | 257·5 | 2175 | 1312 | 28 | 3805 | 907·3 | 4480 | 827 |
| | | | | | 29 | 3924 | 972·0 | 4644 | 826 |
| 10 | 2157 | 203·9 | 1946 | 1264 | 30 | 4043 | 1039 | 4810 | 826 |
| 9 | 1888 | 158·8 | 1727 | 1222 | | | | | |
| 8 | 1635 | 121·0 | 1514 | 1186 | 31 | 4162 | 1110 | 4977 | 826 |
| 7 | 1396 | 89·6 | 1308 | 1153 | 32 | 4281 | 1183 | 5146 | 826 |
| 6 | 1170 | 63·8 | 1108 | 1124 | 33 | 4400 | 1259 | 5317 | 827 |
| | | | | | 34 | 4520 | 1338 | 5490 | 828 |
| 5 | 955 | 43·0 | 914 | 1098 | 35 | 4640 | 1420 | 5666 | 829 |
| 4 | 749 | 26·8 | 723 | 1075 | | | | | |
| 3 | 551 | 14·7 | 537 | 1054 | 36 | 4760 | 1505 | 5843 | 830 |
| 2 | 361 | 6·4 | 355 | 1034 | 37 | 4880 | 1594 | 6024 | 831 |
| 1 | 177 | 1·6 | 176 | 1016 | 38 | 5001 | 1687 | 6207 | 833 |
| | | | | | 39 | 5122 | 1784 | 6392 | 835 |
| 0 | 0 | 0 | 0 | 1000 | 40 | 5244 | 1884 | 6582 | 837 |
| 1 | 172 | 1·5 | 173 | 985 | 41 | 5366 | 1989 | 6774 | 839 |
| 2 | 339 | 5·9 | 344 | 971 | 42 | 5490 | 2098 | 6970 | 842 |
| 3 | 501 | 12·9 | 512 | 958 | 43 | 5614 | 2211 | 7169 | 844 |
| 4 | 659 | 22·6 | 679 | 946 | 44 | 5738 | 2330 | 7373 | 847 |
| 5 | 814 | 34·8 | 844 | 935 | 45 | 5864 | 2453 | 7580 | 850 |
| 6 | 965 | 49·3 | 1007 | 925 | 46 | 5991 | 2582 | 7793 | 854 |
| 7 | 1113 | 66·1 | 1168 | 916 | 47 | 6119 | 2717 | 8009 | 857 |
| 8 | 1257 | 85·2 | 1329 | 907 | 48 | 6247 | 2858 | 8231 | 861 |
| 9 | 1399 | 106·4 | 1488 | 898 | 49 | 6377 | 3004 | 8459 | 865 |
| 10 | 1539 | 129·8 | 1646 | 891 | 50 | 6508 | 3158 | 8692 | 869 |
| 11 | 1677 | 155·3 | 1804 | 884 | 51 | 6641 | 3319 | 8931 | 873 |
| 12 | 1812 | 182·8 | 1961 | 877 | 52 | 6775 | 3487 | 9176 | 877 |
| 13 | 1945 | 212·4 | 2117 | 871 | 53 | 6910 | 3663 | 9428 | 882 |
| 14 | 2077 | 244·0 | 2273 | 866 | 54 | 7046 | 3847 | 9688 | 887 |
| 15 | 2207 | 277·6 | 2428 | 861 | 55 | 7184 | 4041 | 9955 | 892 |
| 16 | 2335 | 313·2 | 2584 | 856 | 56 | 7324 | 4244 | 10231 | 897 |
| 17 | 2463 | 350·9 | 2739 | 852 | 57 | 7465 | 4457 | 10515 | 902 |
| 18 | 2589 | 390·6 | 2895 | 848 | 58 | 7607 | 4681 | 10809 | 907 |
| 19 | 2714 | 432·4 | 3050 | 844 | 59 | 7752 | 4917 | 11112 | 912 |
| 20 | 2838 | 476·3 | 3206 | 841 | 60 | 7898 | 5165 | 11427 | 918 |

XVI. (*continued*).

| $\gamma = 1{\cdot}0$ | | | | | $\gamma = 1{\cdot}0$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) | $\phi$ | (x) | (y) | (T) | (v) |
| 17° | 5941 | 1161 | 4127 | 2763 | 21° | 2898 | 507·8 | 3326 | 823 |
| 16 | 4936 | 862·7 | 3691 | 2132 | 22 | 3015 | 554·2 | 3480 | 820 |
| | | | | | 23 | 3132 | 602·6 | 3634 | 817 |
| 15 | 4254 | 673·4 | 3333 | 1844 | 24 | 3248 | 653·1 | 3790 | 815 |
| 14 | 3720 | 534·9 | 3018 | 1667 | 25 | 3364 | 705·8 | 3946 | 813 |
| 13 | 3272 | 427·4 | 2730 | 1542 | | | | | |
| 12 | 2883 | 341·1 | 2464 | 1447 | 26 | 3479 | 760·7 | 4103 | 811 |
| 11 | 2537 | 270·6 | 2213 | 1372 | 27 | 3594 | 817·9 | 4261 | 810 |
| | | | | | 28 | 3708 | 877·4 | 4420 | 809 |
| 10 | 2224 | 212·5 | 1975 | 1310 | 29 | 3822 | 939·3 | 4581 | 808 |
| 9 | 1936 | 164·3 | 1748 | 1258 | 30 | 3936 | 1004 | 4743 | 808 |
| 8 | 1670 | 124·5 | 1530 | 1214 | | | | | |
| 7 | 1421 | 91·7 | 1319 | 1175 | 31 | 4050 | 1071 | 4906 | 807 |
| 6 | 1187 | 65·0 | 1116 | 1142 | 32 | 4163 | 1140 | 5071 | 807 |
| | | | | | 33 | 4277 | 1213 | 5238 | 807 |
| 5 | 965 | 43·7 | 919 | 1111 | 34 | 4391 | 1288 | 5407 | 808 |
| 4 | 755 | 27·1 | 726 | 1085 | 35 | 4505 | 1367 | 5578 | 808 |
| 3 | 554 | 14·8 | 539 | 1060 | | | | | |
| 2 | 362 | 6·4 | 356 | 1038 | 36 | 4619 | 1448 | 5752 | 809 |
| 1 | 178 | 1·6 | 176 | 1018 | 37 | 4733 | 1533 | 5928 | 810 |
| | | | | | 38 | 4848 | 1621 | 6106 | 812 |
| 0 | 0 | 0 | 0 | 1000 | 39 | 4964 | 1712 | 6287 | 813 |
| | | | | | 40 | 5079 | 1808 | 6471 | 815 |
| 1 | 172 | 1·5 | 173 | 983 | 41 | 5195 | 1907 | 6659 | 817 |
| 2 | 338 | 5·8 | 343 | 968 | 42 | 5312 | 2010 | 6849 | 819 |
| 3 | 499 | 12·9 | 511 | 954 | 43 | 5430 | 2118 | 7044 | 822 |
| 4 | 655 | 22·4 | 677 | 941 | 44 | 5548 | 2230 | 7242 | 824 |
| 5 | 808 | 34·4 | 841 | 929 | 45 | 5667 | 2347 | 7444 | 827 |
| 6 | 957 | 48·7 | 1002 | 918 | 46 | 5787 | 2469 | 7650 | 830 |
| 7 | 1102 | 65·3 | 1163 | 907 | 47 | 5907 | 2596 | 7861 | 833 |
| 8 | 1244 | 84·0 | 1321 | 898 | 48 | 6029 | 2729 | 8077 | 837 |
| 9 | 1383 | 104·8 | 1479 | 889 | 49 | 6152 | 2868 | 8297 | 840 |
| 10 | 1520 | 127·6 | 1636 | 880 | 50 | 6275 | 3013 | 8524 | 844 |
| 11 | 1654 | 152·5 | 1791 | 873 | 51 | 6400 | 3164 | 8756 | 848 |
| 12 | 1785 | 179·3 | 1946 | 866 | 52 | 6526 | 3322 | 8994 | 852 |
| 13 | 1915 | 208·1 | 2100 | 859 | 53 | 6653 | 3488 | 9239 | 856 |
| 14 | 2043 | 238·8 | 2254 | 853 | 54 | 6782 | 3662 | 9491 | 860 |
| 15 | 2169 | 271·4 | 2407 | 847 | 55 | 6912 | 3844 | 9750 | 865 |
| 16 | 2294 | 305·9 | 2560 | 842 | 56 | 7043 | 4035 | 10017 | 869 |
| 17 | 2417 | 342·4 | 2713 | 838 | 57 | 7176 | 4235 | 10293 | 874 |
| 18 | 2539 | 380·8 | 2866 | 833 | 58 | 7310 | 4446 | 10577 | 879 |
| 19 | 2659 | 421·2 | 3019 | 829 | 59 | 7445 | 4667 | 10872 | 884 |
| 20 | 2779 | 463·5 | 3172 | 826 | 60 | 7582 | 4900 | 11177 | 889 |

XVI. (*continued*).

| $\gamma = 1{\cdot}1$ | | | | | $\gamma = 1{\cdot}1$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (x) | (y) | (t) | (v) | $\phi$ | (x) | (y) | (t) | (v) |
| 15° | 4789 | 793·3 | 3502 | 2272 | 25° | 3399 | 737·9 | 4053 | 795 |
| 14 | 4044 | 600·3 | 3130 | 1898 | 27 | 3509 | 792·8 | 4208 | 794 |
| 13 | 3487 | 466·5 | 2810 | 1688 | 28 | 3619 | 850·0 | 4364 | 792 |
| 12 | 3032 | 365·4 | 2521 | 1548 | 29 | 3728 | 909·4 | 4521 | 791 |
| 11 | 2642 | 286·1 | 2255 | 1445 | 30 | 3837 | 971·2 | 4680 | 791 |
| 10 | 2299 | 222·3 | 2006 | 1365 | 31 | 3946 | 1035 | 4840 | 790 |
| 9 | 1989 | 170·5 | 1770 | 1300 | 32 | 4055 | 1102 | 5001 | 790 |
| 8 | 1707 | 128·3 | 1546 | 1245 | 33 | 4164 | 1171 | 5165 | 790 |
| 7 | 1446 | 93·9 | 1331 | 1199 | 34 | 4273 | 1243 | 5330 | 790 |
| 6 | 1204 | 66·3 | 1124 | 1160 | 35 | 4382 | 1318 | 5497 | 790 |
| 5 | 976 | 44·3 | 924 | 1125 | 36 | 4491 | 1396 | 5667 | 791 |
| 4 | 761 | 27·4 | 729 | 1094 | 37 | 4600 | 1477 | 5839 | 792 |
| 3 | 558 | 14·9 | 541 | 1067 | 38 | 4709 | 1561 | 6013 | 793 |
| 2 | 364 | 6·4 | 356 | 1042 | 39 | 4819 | 1648 | 6190 | 794 |
| 1 | 178 | 1·6 | 176 | 1020 | 40 | 4929 | 1739 | 6370 | 796 |
| 0 | 0 | 0 | 0 | 1000 | 41 | 5040 | 1834 | 6552 | 797 |
| | | | | | 42 | 5151 | 1932 | 6738 | 799 |
| 1 | 171 | 1·5 | 173 | 982 | 43 | 5263 | 2035 | 6928 | 801 |
| 2 | 337 | 5·8 | 343 | 965 | 44 | 5375 | 2141 | 7121 | 804 |
| 3 | 497 | 12·8 | 510 | 950 | 45 | 5488 | 2252 | 7318 | 806 |
| 4 | 652 | 22·3 | 675 | 935 | | | | | |
| 5 | 802 | 34·1 | 837 | 922 | | | | | |
| 6 | 949 | 48·2 | 998 | 910 | | | | | |
| 7 | 1091 | 64·5 | 1157 | 899 | | | | | |
| 8 | 1231 | 82·8 | 1314 | 889 | | | | | |
| 9 | 1367 | 103·2 | 1470 | 879 | | | | | |
| 10 | 1501 | 125·5 | 1625 | 870 | | | | | |
| 11 | 1632 | 149·8 | 1779 | 862 | | | | | |
| 12 | 1760 | 176·0 | 1932 | 855 | | | | | |
| 13 | 1887 | 204·0 | 2084 | 848 | | | | | |
| 14 | 2011 | 233·9 | 2235 | 841 | | | | | |
| 15 | 2134 | 265·6 | 2387 | 835 | | | | | |
| 16 | 2255 | 299·1 | 2537 | 830 | | | | | |
| 17 | 2374 | 334·4 | 2688 | 825 | | | | | |
| 18 | 2492 | 371·6 | 2838 | 820 | | | | | |
| 19 | 2609 | 410·7 | 2989 | 816 | | | | | |
| 20 | 2724 | 451·6 | 3139 | 812 | | | | | |
| 21 | 2839 | 494·4 | 3290 | 808 | | | | | |
| 22 | 2952 | 539·1 | 3442 | 805 | | | | | |
| 23 | 3065 | 585·7 | 3593 | 802 | | | | | |
| 24 | 3177 | 634·4 | 3746 | 800 | | | | | |
| 25 | 3288 | 685·1 | 3899 | 797 | | | | | |

| $\gamma = 1{\cdot}2$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (t) | (v) |
| 14° | 4553 | 707·6 | 3287 | 2355 |
| 13 | 3777 | 520·8 | 2909 | 1914 |
| 12 | 3217 | 396·4 | 2589 | 1685 |
| 11 | 2766 | 304·6 | 2303 | 1537 |
| 10 | 2384 | 233·6 | 2040 | 1429 |
| 9 | 2048 | 177·4 | 1795 | 1347 |
| 8 | 1747 | 132·4 | 1564 | 1280 |
| 7 | 1474 | 96·3 | 1343 | 1225 |
| 6 | 1222 | 67·6 | 1132 | 1179 |
| 5 | 987 | 45·0 | 929 | 1139 |
| 4 | 768 | 27·7 | 733 | 1104 |
| 3 | 561 | 15·0 | 542 | 1074 |
| 2 | 365 | 6·5 | 357 | 1047 |
| 1 | 178 | 1·6 | 176 | 1022 |
| 0 | 0 | 0 | 0 | 1000 |

XVI. (*continued*).

| $\gamma = 1{\cdot}2$ | | | | | $\gamma = 1{\cdot}3$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 1° | 171 | 1·5 | 173 | 980 | 13° | 4222 | 607·8 | 3046 | 2325 |
| 2 | 336 | 5·8 | 342 | 962 | 12 | 3460 | 438·4 | 2673 | 1889 |
| 3 | 494 | 12·7 | 509 | 945 | 11 | 2917 | 327·7 | 2359 | 1657 |
| 4 | 648 | 22·1 | 673 | 930 | | | | | |
| 5 | 796 | 33·8 | 834 | 916 | 10 | 2482 | 246·9 | 2079 | 1508 |
| | | | | | 9 | 2114 | 185·2 | 1822 | 1401 |
| 6 | 941 | 47·7 | 994 | 903 | 8 | 1792 | 137·0 | 1582 | 1320 |
| 7 | 1081 | 63·7 | 1152 | 891 | 7 | 1503 | 99·0 | 1356 | 1254 |
| 8 | 1218 | 81·7 | 1307 | 880 | 6 | 1241 | 69·0 | 1141 | 1200 |
| 9 | 1352 | 101·7 | 1462 | 870 | | | | | |
| 10 | 1483 | 123·5 | 1615 | 861 | 5 | 999 | 45·7 | 934 | 1154 |
| | | | | | 4 | 775 | 28·1 | 736 | 1115 |
| 11 | 1611 | 147·3 | 1767 | 852 | 3 | 565 | 15·2 | 544 | 1081 |
| 12 | 1736 | 172·8 | 1918 | 844 | 2 | 366 | 6·5 | 358 | 1051 |
| 13 | 1859 | 200·1 | 2068 | 837 | 1 | 179 | 1·6 | 177 | 1024 |
| 14 | 1981 | 229·2 | 2218 | 830 | 0 | 0 | 0 | 0 | 1000 |
| 15 | 2100 | 260·0 | 2367 | 823 | 1 | 171 | 1·5 | 173 | 978 |
| | | | | | 2 | 335 | 5·8 | 342 | 959 |
| 16 | 2217 | 292·6 | 2515 | 818 | 3 | 492 | 12·6 | 508 | 941 |
| 17 | 2333 | 326·9 | 2664 | 812 | 4 | 644 | 21·9 | 671 | 925 |
| 18 | 2447 | 363·0 | 2812 | 807 | 5 | 791 | 33·5 | 831 | 910 |
| 19 | 2561 | 400·8 | 2960 | 803 | | | | | |
| 20 | 2672 | 440·4 | 3108 | 798 | 6 | 933 | 47·2 | 990 | 896 |
| | | | | | 7 | 1071 | 62·9 | 1146 | 884 |
| 21 | 2783 | 481·8 | 3257 | 795 | 8 | 1206 | 80·6 | 1301 | 872 |
| 22 | 2893 | 525·0 | 3405 | 791 | 9 | 1337 | 100·2 | 1454 | 862 |
| 23 | 3002 | 570·1 | 3555 | 788 | 10 | 1465 | 121·6 | 1605 | 852 |
| 24 | 3110 | 617·1 | 3704 | 785 | | | | | |
| 25 | 3217 | 666·0 | 3855 | 783 | 11 | 1590 | 144·8 | 1756 | 843 |
| | | | | | 12 | 1713 | 169·8 | 1905 | 834 |
| 26 | 3324 | 716·8 | 4006 | 781 | 13 | 1833 | 196·5 | 2053 | 826 |
| 27 | 3430 | 769·7 | 4158 | 779 | 14 | 1951 | 224·8 | 2201 | 819 |
| 28 | 3535 | 824·7 | 4311 | 777 | 15 | 2067 | 254·8 | 2348 | 812 |
| 29 | 3640 | 881·9 | 4465 | 776 | | | | | |
| 30 | 3745 | 941·2 | 4621 | 775 | 16 | 2182 | 286·5 | 2495 | 806 |
| | | | | | 17 | 2294 | 319·9 | 2641 | 800 |
| 31 | 3850 | 1003 | 4778 | 774 | 18 | 2405 | 354·9 | 2787 | 795 |
| 32 | 3955 | 1067 | 4936 | 774 | 19 | 2515 | 391·6 | 2933 | 790 |
| 33 | 4059 | 1133 | 5096 | 773 | 20 | 2624 | 430·0 | 3079 | 786 |
| 34 | 4163 | 1203 | 5258 | 773 | | | | | |
| 35 | 4268 | 1274 | 5422 | 773 | 21 | 2731 | 470·1 | 3225 | 782 |
| | | | | | 22 | 2837 | 511·9 | 3371 | 778 |
| 36 | 4372 | 1349 | 5587 | 774 | 23 | 2942 | 555·5 | 3518 | 775 |
| 37 | 4477 | 1426 | 5755 | 774 | 24 | 3047 | 600·9 | 3665 | 772 |
| 38 | 4582 | 1507 | 5926 | 775 | 25 | 3150 | 648·2 | 3813 | 769 |
| 39 | 4687 | 1590 | 6099 | 776 | | | | | |
| 40 | 4792 | 1677 | 6275 | 778 | 26 | 3253 | 697·3 | 3961 | 767 |
| | | | | | 27 | 3356 | 748·3 | 4111 | 765 |
| 41 | 4898 | 1767 | 6453 | 779 | 28 | 3458 | 801·4 | 4261 | 763 |
| 42 | 5004 | 1861 | 6635 | 781 | 29 | 3559 | 856·4 | 4412 | 762 |
| 43 | 5111 | 1959 | 6820 | 783 | 30 | 3660 | 913·6 | 4565 | 760 |
| 44 | 5218 | 2061 | 7009 | 785 | | | | | |
| 45 | 5326 | 2167 | 7201 | 787 | | | | | |

## XVI. (*continued*).

| $\gamma = 1{\cdot}3$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 31° | 3761 | 973·0 | 4719 | 759 |
| 32 | 3861 | 1035 | 4874 | 759 |
| 33 | 3962 | 1099 | 5031 | 758 |
| 34 | 4062 | 1165 | 5190 | 758 |
| 35 | 4162 | 1234 | 5350 | 758 |
| 36 | 4263 | 1305 | 5513 | 758 |
| 37 | 4363 | 1380 | 5678 | 759 |
| 38 | 4464 | 1457 | 5845 | 759 |
| 39 | 4564 | 1537 | 6014 | 760 |
| 40 | 4665 | 1620 | 6186 | 761 |
| 41 | 4767 | 1707 | 6361 | 763 |
| 42 | 4868 | 1797 | 6539 | 764 |
| 43 | 4971 | 1891 | 6720 | 766 |
| 44 | 5073 | 1988 | 6905 | 768 |
| 45 | 5176 | 2089 | 7093 | 770 |

| $\gamma = 1{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 12° | 3817 | 502·1 | 2784 | 2250 |
| 11 | 3110 | 357·8 | 2426 | 1827 |
| 10 | 2599 | 263·0 | 2123 | 1608 |
| 9 | 2189 | 194·2 | 1852 | 1466 |
| 8 | 1841 | 142·1 | 1602 | 1364 |
| 7 | 1535 | 101·8 | 1370 | 1285 |
| 6 | 1261 | 70·5 | 1150 | 1222 |
| 5 | 1012 | 46·5 | 940 | 1170 |
| 4 | 782 | 28·4 | 739 | 1126 |
| 3 | 568 | 15·3 | 546 | 1088 |
| 2 | 368 | 6·5 | 358 | 1055 |
| 1 | 179 | 1·6 | 177 | 1026 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 171 | 1·5 | 173 | 977 |
| 2 | 333 | 5·7 | 341 | 956 |
| 3 | 490 | 12·6 | 507 | 937 |
| 4 | 640 | 21·7 | 669 | 920 |
| 5 | 785 | 33·2 | 829 | 904 |

| $\gamma = 1{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 6° | 926 | 46·7 | 986 | 890 |
| 7 | 1062 | 62·2 | 1141 | 877 |
| 8 | 1194 | 79·6 | 1294 | 865 |
| 9 | 1323 | 98·8 | 1446 | 853 |
| 10 | 1448 | 119·8 | 1596 | 843 |
| 11 | 1571 | 142·5 | 1745 | 833 |
| 12 | 1691 | 166·9 | 1892 | 825 |
| 13 | 1808 | 193·0 | 2039 | 816 |
| 14 | 1923 | 220·6 | 2185 | 809 |
| 15 | 2037 | 249·9 | 2330 | 802 |
| 16 | 2148 | 280·8 | 2475 | 795 |
| 17 | 2258 | 313·2 | 2619 | 790 |
| 18 | 2366 | 347·3 | 2763 | 784 |
| 19 | 2472 | 382·9 | 2907 | 779 |
| 20 | 2577 | 420·2 | 3050 | 774 |
| 21 | 2681 | 459·1 | 3194 | 770 |
| 22 | 2784 | 499·7 | 3338 | 766 |
| 23 | 2886 | 541·9 | 3483 | 763 |
| 24 | 2987 | 585·9 | 3628 | 760 |
| 25 | 3088 | 631·6 | 3773 | 757 |
| 26 | 3187 | 679·1 | 3919 | 754 |
| 27 | 3286 | 728·4 | 4066 | 752 |
| 28 | 3385 | 779·7 | 4214 | 750 |
| 29 | 3483 | 832·8 | 4362 | 748 |
| 30 | 3580 | 888·0 | 4512 | 747 |
| 31 | 3678 | 945·3 | 4664 | 746 |
| 32 | 3774 | 1005 | 4816 | 745 |
| 33 | 3871 | 1066 | 4970 | 744 |
| 34 | 3968 | 1130 | 5126 | 744 |
| 35 | 4064 | 1197 | 5283 | 744 |
| 36 | 4161 | 1266 | 5443 | 744 |
| 37 | 4258 | 1337 | 5604 | 744 |
| 38 | 4354 | 1411 | 5768 | 745 |
| 39 | 4451 | 1488 | 5934 | 745 |
| 40 | 4548 | 1568 | 6103 | 746 |
| 41 | 4646 | 1652 | 6275 | 747 |
| 42 | 4743 | 1738 | 6449 | 749 |
| 43 | 4841 | 1828 | 6626 | 750 |
| 44 | 4940 | 1921 | 6807 | 752 |
| 45 | 5039 | 2019 | 6991 | 754 |

XVI. (*continued*).

$\gamma = 1{\cdot}5$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 11° | 3373 | 400·5 | 2511 | 2099 |
| 10 | 2743 | 283·2 | 2174 | 1741 |
| 9 | 2275 | 204·8 | 1885 | 1545 |
| 8 | 1895 | 147·8 | 1624 | 1415 |
| 7 | 1569 | 104·9 | 1384 | 1320 |
| 6 | 1282 | 72·2 | 1159 | 1246 |
| 5 | 1025 | 47·3 | 946 | 1187 |
| 4 | 789 | 28·8 | 742 | 1137 |
| 3 | 572 | 15·4 | 547 | 1095 |
| 2 | 369 | 6·6 | 359 | 1059 |
| 1 | 179 | 1·6 | 177 | 1028 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 170 | 1·5 | 172 | 975 |
| 2 | 332 | 5·7 | 341 | 953 |
| 3 | 488 | 12.5 | 505 | 933 |
| 4 | 637 | 21·6 | 667 | 915 |
| 5 | 780 | 32·9 | 826 | 898 |
| 6 | 918 | 46·2 | 982 | 883 |
| 7 | 1053 | 61·5 | 1136 | 870 |
| 8 | 1183 | 78·6 | 1288 | 857 |
| 9 | 1309 | 97·5 | 1438 | 845 |
| 10 | 1432 | 118·1 | 1587 | 835 |
| 11 | 1552 | 140·3 | 1734 | 825 |
| 12 | 1669 | 164·2 | 1880 | 815 |
| 13 | 1784 | 189·6 | 2025 | 807 |
| 14 | 1897 | 216·6 | 2169 | 799 |
| 15 | 2007 | 245·2 | 2312 | 792 |
| 16 | 2116 | 275·3 | 2455 | 785 |
| 17 | 2223 | 306·9 | 2598 | 779 |
| 18 | 2328 | 340·1 | 2740 | 773 |
| 19 | 2431 | 374·7 | 2881 | 768 |
| 20 | 2534 | 411·0 | 3023 | 763 |
| 21 | 2635 | 448·8 | 3165 | 759 |
| 22 | 2735 | 488·1 | 3307 | 755 |
| 23 | 2834 | 529·1 | 3449 | 751 |
| 24 | 2932 | 571·8 | 3592 | 748 |
| 25 | 3029 | 616·1 | 3735 | 745 |
| 26 | 3125 | 662·1 | 3879 | 742 |
| 27 | 3221 | 709·9 | 4023 | 740 |
| 28 | 3316 | 759·4 | 4169 | 738 |
| 29 | 3411 | 810·9 | 4315 | 736 |
| 30 | 3505 | 864·3 | 4462 | 734 |

$\gamma = 1{\cdot}5$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 31° | 3599 | 919·6 | 4611 | 733 |
| 32 | 3693 | 977·0 | 4761 | 732 |
| 33 | 3787 | 1037 | 4912 | 731 |
| 34 | 3880 | 1098 | 5065 | 731 |
| 35 | 3973 | 1162 | 5220 | 731 |
| 36 | 4066 | 1229 | 5377 | 731 |
| 37 | 4159 | 1298 | 5535 | 731 |
| 38 | 4253 | 1369 | 5696 | 731 |
| 39 | 4346 | 1444 | 5859 | 732 |
| 40 | 4439 | 1521 | 6025 | 732 |
| 41 | 4533 | 1601 | 6193 | 733 |
| 42 | 4627 | 1684 | 6364 | 735 |
| 43 | 4722 | 1770 | 6538 | 736 |
| 44 | 4816 | 1860 | 6715 | 738 |
| 45 | 4911 | 1954 | 6896 | 739 |

$\gamma = 1{\cdot}6$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 10° | 2927 | 309·8 | 2236 | 1933 |
| 9 | 2377 | 217·5 | 1922 | 1644 |
| 8 | 1955 | 154·3 | 1648 | 1475 |
| 7 | 1606 | 108·3 | 1399 | 1359 |
| 6 | 1305 | 73·9 | 1169 | 1272 |
| 5 | 1038 | 48·2 | 952 | 1204 |
| 4 | 797 | 29·1 | 746 | 1149 |
| 3 | 576 | 15·6 | 549 | 1103 |
| 2 | 371 | 6·6 | 360 | 1064 |
| 1 | 180 | 1·6 | 177 | 1030 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 170 | 1·5 | 172 | 974 |
| 2 | 331 | 5·7 | 340 | 950 |
| 3 | 485 | 12·4 | 504 | 929 |
| 4 | 633 | 21·4 | 665 | 910 |
| 5 | 775 | 32·6 | 823 | 893 |
| 6 | 911 | 45·7 | 978 | 877 |
| 7 | 1044 | 60·8 | 1131 | 863 |
| 8 | 1171 | 77·6 | 1282 | 850 |
| 9 | 1296 | 96·2 | 1430 | 838 |
| 10 | 1416 | 116·4 | 1578 | 826 |

## XVI. (*continued*).

$\gamma = 1{\cdot}6$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 11° | 1534 | 138·2 | 1723 | 816 |
| 12 | 1649 | 161·5 | 1868 | 807 |
| 13 | 1761 | 186·4 | 2011 | 798 |
| 14 | 1871 | 212·9 | 2154 | 790 |
| 15 | 1979 | 240·7 | 2296 | 782 |
| 16 | 2085 | 270·1 | 2437 | 776 |
| 17 | 2189 | 300·9 | 2577 | 769 |
| 18 | 2292 | 333·2 | 2717 | 763 |
| 19 | 2393 | 367·0 | 2857 | 758 |
| 20 | 2492 | 402·3 | 2997 | 753 |
| 21 | 2590 | 439·0 | 3137 | 748 |
| 22 | 2688 | 477·3 | 3277 | 744 |
| 23 | 2784 | 517·1 | 3417 | 740 |
| 24 | 2879 | 558·5 | 3558 | 737 |
| 25 | 2973 | 601·5 | 3699 | 734 |
| 26 | 3067 | 646·2 | 3840 | 731 |
| 27 | 3160 | 692·5 | 3983 | 729 |
| 28 | 3252 | 740·6 | 4126 | 726 |
| 29 | 3344 | 790·4 | 4270 | 724 |
| 30 | 3435 | 842·1 | 4415 | 723 |
| 31 | 3526 | 895·7 | 4561 | 721 |
| 32 | 3617 | 951·2 | 4709 | 720 |
| 33 | 3707 | 1009 | 4858 | 719 |
| 34 | 3798 | 1069 | 5008 | 719 |
| 35 | 3888 | 1131 | 5160 | 718 |
| 36 | 3978 | 1195 | 5314 | 718 |
| 37 | 4068 | 1261 | 5470 | 718 |
| 38 | 4158 | 1330 | 5628 | 718 |
| 39 | 4248 | 1402 | 5788 | 719 |
| 40 | 4338 | 1476 | 5951 | 720 |
| 41 | 4429 | 1554 | 6116 | 720 |
| 42 | 4519 | 1634 | 6284 | 721 |
| 43 | 4610 | 1717 | 6455 | 723 |
| 44 | 4702 | 1804 | 6629 | 724 |
| 45 | 4793 | 1894 | 6807 | 726 |

$\gamma = 1{\cdot}7$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 10° | 3186 | 348·4 | 2316 | 2254 |
| 9 | 2501 | 233·2 | 1966 | 1775 |
| 8 | 2025 | 161·9 | 1675 | 1546 |
| 7 | 1647 | 112·1 | 1416 | 1403 |
| 6 | 1329 | 75·8 | 1179 | 1301 |
| 5 | 1052 | 49·0 | 958 | 1223 |
| 4 | 804 | 29·5 | 749 | 1162 |
| 3 | 579 | 15·7 | 551 | 1111 |
| 2 | 372 | 6·6 | 361 | 1068 |
| 1 | 180 | 1·6 | 177 | 1032 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 1{\cdot}8$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 9° | 2658 | 253·7 | 2018 | 1961 |
| 8 | 2105 | 170·7 | 1704 | 1634 |
| 7 | 1693 | 116·3 | 1434 | 1453 |
| 6 | 1356 | 77·8 | 1190 | 1332 |
| 5 | 1067 | 50·0 | 964 | 1243 |
| 4 | 813 | 29·9 | 753 | 1175 |
| 3 | 583 | 15·9 | 553 | 1119 |
| 2 | 374 | 6·7 | 361 | 1073 |
| 1 | 180 | 1·6 | 177 | 1034 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 169 | 1·5 | 172 | 971 |
| 2 | 329 | 5·6 | 339 | 945 |
| 3 | 481 | 12·3 | 502 | 922 |
| 4 | 626 | 21·1 | 661 | 901 |
| 5 | 765 | 32·0 | 817 | 882 |
| 6 | 898 | 44·8 | 971 | 865 |
| 7 | 1026 | 59·4 | 1121 | 850 |
| 8 | 1150 | 75·8 | 1270 | 836 |
| 9 | 1270 | 93·7 | 1416 | 823 |
| 10 | 1387 | 113·2 | 1560 | 811 |

XVI. (*continued*).

| $\gamma = 1{\cdot}8$ | | | | | $\gamma = 1{\cdot}9$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 11° | 1500 | 134·2 | 1703 | 800 | 9° | 2874 | 282·7 | 2084 | 2262 |
| 12 | 1610 | 156·6 | 1845 | 790 | 8 | 2200 | 181·4 | 1738 | 1746 |
| 13 | 1718 | 180·5 | 1986 | 781 | 7 | 1743 | 121·0 | 1453 | 1511 |
| 14 | 1823 | 205·8 | 2125 | 773 | 6 | 1384 | 80·0 | 1201 | 1366 |
| 15 | 1926 | 232·4 | 2263 | 765 | 5 | 1083 | 51·0 | 971 | 1265 |
| 16 | 2027 | 260·5 | 2401 | 757 | 4 | 821 | 30·3 | 757 | 1188 |
| 17 | 2127 | 289·9 | 2539 | 751 | 3 | 587 | 16·0 | 554 | 1127 |
| 18 | 2224 | 320·6 | 2675 | 745 | 2 | 375 | 6·7 | 362 | 1078 |
| 19 | 2320 | 352·7 | 2812 | 739 | 1 | 181 | 1·6 | 178 | 1036 |
| 20 | 2415 | 386·2 | 2948 | 734 | 0 | 0 | 0 | 0 | 1000 |
| 21 | 2508 | 421·1 | 3084 | 729 | | | | | |
| 22 | 2600 | 457·4 | 3221 | 724 | | | | | |
| 23 | 2691 | 495·1 | 3357 | 720 | | | | | |
| 24 | 2782 | 534·3 | 3494 | 717 | | | | | |
| 25 | 2871 | 575·0 | 3631 | 713 | | | | | |
| 26 | 2959 | 617·1 | 3769 | 710 | | | | | |
| 27 | 3047 | 660·9 | 3907 | 708 | | | | | |
| 28 | 3134 | 706·2 | 4046 | 705 | | | | | |
| 29 | 3221 | 753·2 | 4186 | 703 | | | | | |
| 30 | 3307 | 801·9 | 4327 | 701 | | | | | |
| 31 | 3392 | 852·3 | 4469 | 700 | | | | | |
| 32 | 3478 | 904·6 | 4612 | 698 | | | | | |
| 33 | 3563 | 958·8 | 4756 | 697 | | | | | |
| 34 | 3647 | 1015 | 4902 | 697 | | | | | |
| 35 | 3732 | 1073 | 5049 | 696 | | | | | |
| 36 | 3816 | 1133 | 5198 | 696 | | | | | |
| 37 | 3901 | 1196 | 5349 | 695 | | | | | |
| 38 | 3985 | 1260 | 5502 | 695 | | | | | |
| 39 | 4070 | 1328 | 5658 | 696 | | | | | |
| 40 | 4154 | 1397 | 5815 | 696 | | | | | |
| 41 | 4239 | 1470 | 5975 | 697 | | | | | |
| 42 | 4324 | 1545 | 6137 | 698 | | | | | |
| 43 | 4409 | 1623 | 6302 | 699 | | | | | |
| 44 | 4494 | 1704 | 6471 | 700 | | | | | |
| 45 | 4580 | 1788 | 6642 | 701 | | | | | |

| $\gamma = 2{\cdot}0$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 8° | 2316 | 194·8 | 1777 | 1896 |
| 7 | 1799 | 126·5 | 1474 | 1579 |
| 6 | 1414 | 82·4 | 1214 | 1404 |
| 5 | 1099 | 52·0 | 978 | 1288 |
| 4 | 829 | 30·7 | 761 | 1202 |
| 3 | 591 | 16·2 | 556 | 1136 |
| 2 | 377 | 6·8 | 363 | 1082 |
| 1 | 181 | 1·6 | 178 | 1038 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 169 | 1·5 | 172 | 968 |
| 2 | 327 | 5·6 | 338 | 939 |
| 3 | 477 | 12·1 | 500 | 914 |
| 4 | 619 | 20·8 | 658 | 892 |
| 5 | 755 | 31·5 | 812 | 872 |
| 6 | 885 | 44·0 | 963 | 854 |
| 7 | 1010 | 58·2 | 1112 | 838 |
| 8 | 1130 | 74·0 | 1258 | 823 |
| 9 | 1246 | 91·4 | 1402 | 809 |
| 10 | 1359 | 110·2 | 1544 | 797 |

## XVI. (*continued*).

| $\gamma = 2\cdot0$ | | | | | $\gamma = 2\cdot1$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 11° | 1468 | 130·5 | 1684 | 786 | 8° | 2467 | 212·5 | 1824 | 2116 |
| 12 | 1574 | 152·1 | 1823 | 775 | 7 | 1864 | 132·8 | 1498 | 1663 |
| 13 | 1678 | 175·0 | 1961 | 766 | 6 | 1447 | 85·1 | 1227 | 1447 |
| 14 | 1779 | 199·3 | 2098 | 757 | | | | | |
| 15 | 1878 | 224·8 | 2233 | 749 | 5 | 1117 | 53·2 | 986 | 1312 |
| | | | | | 4 | 838 | 31·2 | 765 | 1217 |
| 16 | 1974 | 251·7 | 2368 | 741 | 3 | 596 | 16·3 | 558 | 1145 |
| 17 | 2069 | 279·8 | 2502 | 734 | 2 | 379 | 6·8 | 364 | 1087 |
| 18 | 2163 | 309·2 | 2636 | 728 | 1 | 181 | 1·6 | 178 | 1040 |
| 19 | 2254 | 339·8 | 2770 | 722 | 0 | 0 | 0 | 0 | 1000 |
| 20 | 2344 | 371·8 | 2903 | 716 | | | | | |
| 21 | 2433 | 405·0 | 3036 | 711 | | | | | |
| 22 | 2521 | 439·6 | 3169 | 707 | | | | | |
| 23 | 2608 | 475·4 | 3302 | 702 | | | | | |
| 24 | 2693 | 512·7 | 3435 | 699 | | | | | |
| 25 | 2778 | 551·3 | 3569 | 695 | | | | | |
| 26 | 2862 | 591·3 | 3703 | 692 | | | | | |
| 27 | 2945 | 632·8 | 3837 | 689 | | | | | |
| 28 | 3028 | 675·8 | 3973 | 687 | | | | | |
| 29 | 3110 | 720·3 | 4109 | 684 | | | | | |
| 30 | 3191 | 766·4 | 4246 | 682 | | | | | |
| 31 | 3272 | 814·1 | 4384 | 681 | | | | | |
| 32 | 3353 | 863·5 | 4523 | 679 | | | | | |
| 33 | 3433 | 914·7 | 4663 | 678 | | | | | |
| 34 | 3513 | 967·7 | 4805 | 677 | | | | | |
| 35 | 3593 | 1023 | 4948 | 676 | | | | | |
| 36 | 3673 | 1079 | 5093 | 676 | | | | | |
| 37 | 3752 | 1138 | 5240 | 675 | | | | | |
| 38 | 3832 | 1199 | 5389 | 675 | | | | | |
| 39 | 3911 | 1263 | 5539 | 675 | | | | | |
| 40 | 3991 | 1328 | 5692 | 676 | | | | | |
| 41 | 4071 | 1396 | 5847 | 676 | | | | | |
| 42 | 4151 | 1467 | 6005 | 677 | | | | | |
| 43 | 4231 | 1540 | 6165 | 678 | | | | | |
| 44 | 4311 | 1617 | 6328 | 679 | | | | | |
| 45 | 4391 | 1696 | 6494 | 680 | | | | | |

| $\gamma = 2\cdot2$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 8° | 2680 | 238·4 | 1885 | 2495 |
| 7 | 1940 | 140·3 | 1525 | 1766 |
| 6 | 1483 | 88·0 | 1241 | 1496 |
| 5 | 1135 | 54·4 | 993 | 1339 |
| 4 | 848 | 31·7 | 769 | 1233 |
| 3 | 600 | 16·5 | 560 | 1154 |
| 2 | 380 | 6·8 | 364 | 1092 |
| 1 | 182 | 1·6 | 178 | 1042 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 168 | 1·5 | 171 | 965 |
| 2 | 325 | 5·6 | 337 | 934 |
| 3 | 473 | 12·0 | 498 | 907 |
| 4 | 613 | 20·5 | 654 | 883 |
| 5 | 746 | 31·0 | 807 | 862 |
| 6 | 873 | 43·2 | 956 | 843 |
| 7 | 994 | 57·0 | 1103 | 826 |
| 8 | 1111 | 72·4 | 1247 | 811 |
| 9 | 1224 | 89·2 | 1389 | 797 |
| 10 | 1333 | 107·4 | 1529 | 784 |

XVI. (*continued*).

| $\gamma = 2\cdot2$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 11° | 1438 | 127·0 | 1667 | 772 |
| 12 | 1541 | 147·9 | 1803 | 761 |
| 13 | 1640 | 170·0 | 1938 | 751 |
| 14 | 1738 | 193·3 | 2072 | 742 |
| 15 | 1833 | 217·9 | 2205 | 734 |
| 16 | 1926 | 243·6 | 2337 | 726 |
| 17 | 2017 | 270·6 | 2469 | 719 |
| 18 | 2106 | 298·8 | 2600 | 712 |
| 19 | 2194 | 328·1 | 2730 | 706 |
| 20 | 2280 | 358·7 | 2861 | 700 |
| 21 | 2365 | 390·4 | 2991 | 695 |
| 22 | 2449 | 423·4 | 3120 | 690 |
| 23 | 2531 | 457·7 | 3251 | 686 |
| 24 | 2613 | 493·2 | 3381 | 682 |
| 25 | 2694 | 530·0 | 3511 | 679 |
| 26 | 2774 | 568·1 | 3642 | 675 |
| 27 | 2853 | 607·6 | 3773 | 672 |
| 28 | 2931 | 648·5 | 3905 | 670 |
| 29 | 3009 | 690·8 | 4038 | 667 |
| 30 | 3087 | 734·7 | 4172 | 665 |
| 31 | 3164 | 780·0 | 4306 | 663 |
| 32 | 3240 | 826·9 | 4442 | 662 |
| 33 | 3317 | 875·5 | 4579 | 660 |
| 34 | 3393 | 925·8 | 4717 | 659 |
| 35 | 3468 | 977·8 | 4856 | 658 |
| 36 | 3544 | 1032 | 4997 | 658 |
| 37 | 3619 | 1088 | 5140 | 657 |
| 38 | 3695 | 1145 | 5285 | 657 |
| 39 | 3770 | 1205 | 5431 | 657 |
| 40 | 3845 | 1267 | 5580 | 657 |
| 41 | 3921 | 1332 | 5731 | 658 |
| 42 | 3996 | 1399 | 5884 | 658 |
| 43 | 4072 | 1468 | 6040 | 659 |
| 44 | 4148 | 1540 | 6199 | 660 |
| 45 | 4224 | 1615 | 6360 | 661 |

| $\gamma = 2\cdot3$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 7° | 2032 | 149·5 | 1555 | 1902 |
| 6 | 1524 | 91·3 | 1256 | 1552 |
| 5 | 1155 | 55·7 | 1001 | 1368 |
| 4 | 858 | 32·2 | 773 | 1249 |
| 3 | 604 | 16·6 | 562 | 1163 |
| 2 | 382 | 6·9 | 365 | 1097 |
| 1 | 182 | 1·6 | 178 | 1044 |
| 0 | 0 | 0 | 0 | 1000 |

| $\gamma = 2\cdot4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 7° | 2146 | 161·3 | 1591 | 2093 |
| 6 | 1569 | 95·0 | 1273 | 1617 |
| 5 | 1176 | 57·1 | 1010 | 1400 |
| 4 | 868 | 32·7 | 777 | 1267 |
| 3 | 609 | 16·8 | 564 | 1173 |
| 2 | 383 | 6·9 | 366 | 1102 |
| 1 | 182 | 1·6 | 179 | 1046 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 168 | 1·5 | 171 | 962 |
| 2 | 324 | 5·5 | 336 | 929 |
| 3 | 469 | 11·9 | 496 | 900 |
| 4 | 607 | 20·3 | 651 | 875 |
| 5 | 737 | 30·5 | 802 | 853 |
| 6 | 861 | 42·4 | 950 | 833 |
| 7 | 979 | 55·9 | 1095 | 815 |
| 8 | 1093 | 70·9 | 1237 | 799 |
| 9 | 1202 | 87·2 | 1376 | 785 |
| 10 | 1308 | 104·9 | 1514 | 771 |
| 11 | 1410 | 123·8 | 1650 | 759 |
| 12 | 1509 | 143·9 | 1784 | 748 |
| 13 | 1605 | 165·3 | 1917 | 738 |
| 14 | 1699 | 187·8 | 2048 | 728 |
| 15 | 1791 | 211·5 | 2179 | 720 |
| 16 | 1880 | 236·3 | 2308 | 712 |
| 17 | 1968 | 262·2 | 2437 | 705 |
| 18 | 2053 | 289·2 | 2566 | 698 |
| 19 | 2138 | 317·4 | 2693 | 692 |
| 20 | 2220 | 346·7 | 2821 | 686 |

XVI. (*continued*).

| $\gamma = 2{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 21° | 2302 | 377·2 | 2948 | 681 |
| 22 | 2382 | 408·8 | 3075 | 676 |
| 23 | 2461 | 441·6 | 3203 | 671 |
| 24 | 2539 | 475·5 | 3330 | 667 |
| 25 | 2617 | 510·7 | 3455 | 663 |
| 26 | 2693 | 547·2 | 3586 | 660 |
| 27 | 2769 | 584·9 | 3714 | 657 |
| 28 | 2844 | 624·0 | 3843 | 654 |
| 29 | 2918 | 664·4 | 3973 | 652 |
| 30 | 2992 | 706·2 | 4103 | 650 |
| 31 | 3065 | 749·4 | 4235 | 648 |
| 32 | 3138 | 794·1 | 4367 | 646 |
| 33 | 3211 | 840·4 | 4500 | 645 |
| 34 | 3283 | 888·3 | 4635 | 643 |
| 35 | 3355 | 937·9 | 4771 | 642 |
| 36 | 3427 | 989·2 | 4909 | 642 |
| 37 | 3499 | 1042 | 5048 | 641 |
| 38 | 3571 | 1097 | 5189 | 641 |
| 39 | 3642 | 1154 | 5332 | 641 |
| 40 | 3714 | 1213 | 5477 | 641 |
| 41 | 3786 | 1275 | 5624 | 641 |
| 42 | 3858 | 1338 | 5773 | 641 |
| 43 | 3929 | 1404 | 5925 | 642 |
| 44 | 4001 | 1472 | 6080 | 643 |
| 45 | 4074 | 1543 | 6237 | 644 |

| $\gamma = 2{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 7° | 2300 | 177·6 | 1636 | 2395 |
| 6 | 1619 | 99·3 | 1291 | 1695 |
| 5 | 1199 | 58·6 | 1019 | 1435 |
| 4 | 878 | 33·2 | 782 | 1285 |
| 3 | 613 | 17·0 | 566 | 1183 |
| 2 | 385 | 7·0 | 367 | 1107 |
| 1 | 183 | 1·6 | 179 | 1048 |
| 0 | 0 | 0 | 0 | 1000 |

| $\gamma = 2{\cdot}6$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 6° | 1678 | 104·3 | 1311 | 1790 |
| 5 | 1223 | 60·2 | 1028 | 1474 |
| 4 | 889 | 33·8 | 786 | 1305 |
| 3 | 618 | 17·1 | 569 | 1193 |
| 2 | 387 | 7·0 | 367 | 1113 |
| 1 | 183 | 1·6 | 179 | 1050 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 167 | 1·4 | 171 | 959 |
| 2 | 322 | 5·5 | 335 | 923 |
| 3 | 466 | 11·7 | 494 | 893 |
| 4 | 601 | 20·0 | 648 | 867 |
| 5 | 728 | 30·0 | 797 | 844 |
| 6 | 849 | 41·7 | 943 | 823 |
| 7 | 965 | 54·8 | 1086 | 805 |
| 8 | 1076 | 69·4 | 1226 | 788 |
| 9 | 1182 | 85·3 | 1364 | 773 |
| 10 | 1284 | 102·4 | 1500 | 760 |
| 11 | 1383 | 120·8 | 1634 | 747 |
| 12 | 1479 | 140·3 | 1766 | 736 |
| 13 | 1572 | 160·9 | 1896 | 725 |
| 14 | 1663 | 182·7 | 2025 | 716 |
| 15 | 1751 | 205·5 | 2154 | 707 |
| 16 | 1838 | 229·4 | 2281 | 699 |
| 17 | 1922 | 254·4 | 2408 | 692 |
| 18 | 2005 | 280·5 | 2533 | 685 |
| 19 | 2086 | 307·6 | 2659 | 678 |
| 20 | 2165 | 335·7 | 2784 | 672 |
| 21 | 2243 | 365·0 | 2909 | 667 |
| 22 | 2321 | 395·4 | 3033 | 662 |
| 23 | 2397 | 426·8 | 3158 | 658 |
| 24 | 2471 | 459·4 | 3283 | 653 |
| 25 | 2546 | 493·2 | 3408 | 650 |
| 26 | 2619 | 528·1 | 3533 | 646 |
| 27 | 2691 | 564·3 | 3659 | 643 |
| 28 | 2763 | 601·7 | 3785 | 640 |
| 29 | 2834 | 640·4 | 3912 | 638 |
| 30 | 2905 | 680·3 | 4039 | 635 |
| 31 | 2975 | 721·7 | 4168 | 633 |
| 32 | 3045 | 764·5 | 4297 | 632 |
| 33 | 3115 | 808·7 | 4428 | 630 |
| 34 | 3184 | 854·5 | 4560 | 629 |
| 35 | 3253 | 901·8 | 4693 | 628 |

XVI. (*continued*).

$\gamma = 2{\cdot}6$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 36° | 3321 | 950·8 | 4827 | 627 |
| 37 | 3390 | 1002 | 4963 | 626 |
| 38 | 3458 | 1054 | 5101 | 626 |
| 39 | 3527 | 1108 | 5241 | 626 |
| 40 | 3595 | 1165 | 5382 | 626 |
| 41 | 3663 | 1223 | 5526 | 626 |
| 42 | 3732 | 1284 | 5672 | 626 |
| 43 | 3800 | 1346 | 5820 | 627 |
| 44 | 3868 | 1412 | 5971 | 628 |
| 45 | 3938 | 1479 | 6124 | 629 |

$\gamma = 2{\cdot}7$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 6° | 1747 | 110·2 | 1334 | 1912 |
| 5 | 1250 | 62·0 | 1039 | 1517 |
| 4 | 901 | 34·4 | 791 | 1325 |
| 3 | 623 | 17·3 | 571 | 1204 |
| 2 | 389 | 7·0 | 368 | 1118 |
| 1 | 184 | 1·6 | 179 | 1052 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 2{\cdot}8$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 6° | 1831 | 117·6 | 1360 | 2075 |
| 5 | 1279 | 64·0 | 1049 | 1566 |
| 4 | 913 | 35·0 | 796 | 1348 |
| 3 | 628 | 17·5 | 573 | 1215 |
| 2 | 390 | 7·1 | 369 | 1123 |
| 1 | 184 | 1·6 | 179 | 1055 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 167 | 1·4 | 171 | 956 |
| 2 | 320 | 5·4 | 334 | 918 |
| 3 | 462 | 11·6 | 492 | 887 |
| 4 | 595 | 19·7 | 644 | 859 |
| 5 | 720 | 29·6 | 793 | 835 |

$\gamma = 2{\cdot}8$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 6° | 839 | 41·0 | 937 | 814 |
| 7 | 951 | 53·8 | 1078 | 795 |
| 8 | 1059 | 68·0 | 1217 | 778 |
| 9 | 1163 | 83·5 | 1353 | 762 |
| 10 | 1262 | 100·1 | 1486 | 749 |
| 11 | 1358 | 118·0 | 1618 | 736 |
| 12 | 1451 | 136·9 | 1748 | 724 |
| 13 | 1542 | 156·9 | 1877 | 714 |
| 14 | 1629 | 177·9 | 2004 | 704 |
| 15 | 1715 | 200·0 | 2130 | 695 |
| 16 | 1798 | 223·1 | 2255 | 687 |
| 17 | 1879 | 247·2 | 2379 | 679 |
| 18 | 1959 | 272·3 | 2503 | 672 |
| 19 | 2037 | 298·5 | 2626 | 666 |
| 20 | 2114 | 325·6 | 2749 | 660 |
| 21 | 2189 | 353·8 | 2871 | 655 |
| 22 | 2264 | 383·0 | 2994 | 650 |
| 23 | 2337 | 413·3 | 3116 | 645 |
| 24 | 2409 | 444·7 | 3238 | 641 |
| 25 | 2480 | 477·1 | 3361 | 637 |
| 26 | 2550 | 510·7 | 3484 | 633 |
| 27 | 2620 | 545·4 | 3607 | 630 |
| 28 | 2689 | 581·3 | 3731 | 627 |
| 29 | 2757 | 618·5 | 3855 | 625 |
| 30 | 2825 | 656·8 | 3980 | 622 |
| 31 | 2893 | 696·5 | 4106 | 620 |
| 32 | 2960 | 737·6 | 4233 | 618 |
| 33 | 3026 | 780·0 | 4360 | 617 |
| 34 | 3092 | 823·8 | 4489 | 616 |
| 35 | 3158 | 869·2 | 4620 | 614 |
| 36 | 3224 | 916·1 | 4751 | 614 |
| 37 | 3290 | 964·7 | 4884 | 613 |
| 38 | 3355 | 1015 | 5019 | 612 |
| 39 | 3421 | 1067 | 5156 | 612 |
| 40 | 3486 | 1121 | 5294 | 612 |
| 41 | 3552 | 1177 | 5435 | 612 |
| 42 | 3617 | 1235 | 5577 | 612 |
| 43 | 3683 | 1295 | 5722 | 613 |
| 44 | 3748 | 1357 | 5870 | 614 |
| 45 | 3814 | 1422 | 6020 | 614 |

XVI. (*continued*).

$\gamma = 2\cdot9$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 6° | 1939 | 127·3 | 1392 | 2312 |
| 5 | 1311 | 66·2 | 1061 | 1622 |
| 4 | 926 | 35·7 | 802 | 1371 |
| 3 | 633 | 17·7 | 575 | 1227 |
| 2 | 392 | 7·1 | 370 | 1129 |
| 1 | 184 | 1·6 | 179 | 1057 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 3\cdot0$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 5° | 1346 | 68·6 | 1074 | 1687 |
| 4 | 939 | 36·4 | 807 | 1397 |
| 3 | 639 | 17·9 | 578 | 1239 |
| 2 | 394 | 7·2 | 371 | 1135 |
| 1 | 185 | 1·6 | 180 | 1059 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 166 | 1·4 | 170 | 953 |
| 2 | 318 | 5·4 | 333 | 914 |
| 3 | 458 | 11·5 | 490 | 880 |
| 4 | 589 | 19·5 | 641 | 852 |
| 5 | 712 | 29·1 | 788 | 827 |
| 6 | 828 | 40·3 | 931 | 805 |
| 7 | 938 | 52·9 | 1071 | 785 |
| 8 | 1044 | 66·7 | 1207 | 768 |
| 9 | 1144 | 81·8 | 1342 | 752 |
| 10 | 1241 | 98·0 | 1473 | 738 |
| 11 | 1335 | 115·3 | 1603 | 725 |
| 12 | 1425 | 133·7 | 1731 | 714 |
| 13 | 1513 | 153·1 | 1858 | 703 |
| 14 | 1598 | 173·5 | 1983 | 693 |
| 15 | 1680 | 194·9 | 2107 | 684 |
| 16 | 1761 | 217·2 | 2230 | 676 |
| 17 | 1840 | 240·5 | 2353 | 668 |
| 18 | 1917 | 264·8 | 2474 | 661 |
| 19 | 1992 | 290·1 | 2595 | 654 |
| 20 | 2066 | 316·3 | 2716 | 648 |

$\gamma = 3\cdot0$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 21° | 2139 | 343·5 | 2836 | 643 |
| 22 | 2210 | 371·7 | 2956 | 638 |
| 23 | 2281 | 400·9 | 3076 | 633 |
| 24 | 2351 | 431·1 | 3197 | 629 |
| 25 | 2419 | 462·4 | 3317 | 625 |
| 26 | 2487 | 494·7 | 3437 | 622 |
| 27 | 2554 | 528·1 | 3558 | 618 |
| 28 | 2620 | 562·7 | 3679 | 615 |
| 29 | 2686 | 598·4 | 3801 | 613 |
| 30 | 2751 | 635·3 | 3924 | 610 |
| 31 | 2816 | 673·5 | 4047 | 608 |
| 32 | 2881 | 712·9 | 4172 | 606 |
| 33 | 2944 | 753·7 | 4297 | 605 |
| 34 | 3008 | 795·8 | 4423 | 603 |
| 35 | 3072 | 839·4 | 4551 | 602 |
| 36 | 3135 | 884·5 | 4680 | 601 |
| 37 | 3198 | 931·1 | 4811 | 601 |
| 38 | 3261 | 979·4 | 4943 | 600 |
| 39 | 3323 | 1029 | 5076 | 600 |
| 40 | 3386 | 1081 | 5212 | 600 |
| 41 | 3449 | 1135 | 5350 | 600 |
| 42 | 3512 | 1190 | 5489 | 600 |
| 43 | 3575 | 1248 | 5631 | 600 |
| 44 | 3637 | 1307 | 5776 | 601 |
| 45 | 3700 | 1369 | 5923 | 602 |

$\gamma = 3\cdot1$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 5° | 1386 | 71·4 | 1088 | 1764 |
| 4 | 954 | 37·2 | 813 | 1424 |
| 3 | 644 | 18·1 | 580 | 1252 |
| 2 | 396 | 7·2 | 372 | 1141 |
| 1 | 185 | 1·7 | 180 | 1061 |
| 0 | 0 | 0 | 0 | 1000 |

XVI. (*continued*).

| $\gamma = 3{\cdot}2$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 5° | 1431 | 74·7 | 1103 | 1857 |
| 4 | 969 | 38·0 | 819 | 1454 |
| 3 | 650 | 18·4 | 582 | 1265 |
| 2 | 398 | 7·3 | 372 | 1146 |
| 1 | 185 | 1·7 | 180 | 1063 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 166 | 1·4 | 170 | 950 |
| 2 | 316 | 5·4 | 332 | 909 |
| 3 | 455 | 11·4 | 488 | 874 |
| 4 | 584 | 19·2 | 638 | 845 |
| 5 | 704 | 28·7 | 784 | 819 |
| 6 | 818 | 39·7 | 925 | 796 |
| 7 | 926 | 52·0 | 1063 | 777 |
| 8 | 1029 | 65·5 | 1198 | 759 |
| 9 | 1127 | 80·2 | 1331 | 743 |
| 10 | 1221 | 96·0 | 1461 | 728 |
| 11 | 1312 | 112·8 | 1589 | 715 |
| 12 | 1400 | 130·7 | 1715 | 703 |
| 13 | 1485 | 149·5 | 1840 | 693 |
| 14 | 1568 | 169·3 | 1964 | 683 |
| 15 | 1648 | 190·0 | 2086 | 673 |
| 16 | 1726 | 211·7 | 2207 | 665 |
| 17 | 1802 | 234·3 | 2327 | 657 |
| 18 | 1877 | 257·8 | 2447 | 650 |
| 19 | 1950 | 282·2 | 2566 | 644 |
| 20 | 2021 | 307·6 | 2685 | 638 |
| 21 | 2092 | 333·9 | 2803 | 632 |
| 22 | 2161 | 361·2 | 2921 | 627 |
| 23 | 2229 | 389·4 | 3039 | 622 |
| 24 | 2296 | 418·5 | 3157 | 618 |
| 25 | 2362 | 448·7 | 3275 | 614 |
| 26 | 2428 | 479·9 | 3394 | 611 |
| 27 | 2492 | 512·2 | 3512 | 607 |
| 28 | 2556 | 545·5 | 3631 | 604 |
| 29 | 2620 | 580·0 | 3751 | 602 |
| 30 | 2683 | 615·5 | 3872 | 599 |
| 31 | 2745 | 652·3 | 3993 | 597 |
| 32 | 2807 | 690·3 | 4115 | 595 |
| 33 | 2869 | 729·6 | 4238 | 593 |
| 34 | 2930 | 770·2 | 4362 | 592 |
| 35 | 2991 | 812·1 | 4487 | 591 |

| $\gamma = 3{\cdot}2$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 36° | 3052 | 855·5 | 4614 | 590 |
| 37 | 3113 | 900·4 | 4742 | 589 |
| 38 | 3173 | 946·8 | 4871 | 589 |
| 39 | 3234 | 994·9 | 5002 | 588 |
| 40 | 3294 | 1045 | 5135 | 588 |
| 41 | 3354 | 1096 | 5270 | 588 |
| 42 | 3415 | 1150 | 5407 | 588 |
| 43 | 3475 | 1205 | 5546 | 588 |
| 44 | 3536 | 1262 | 5688 | 589 |
| 45 | 3596 | 1322 | 5832 | 590 |

| $\gamma = 3{\cdot}3$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 5° | 1484 | 78·5 | 1120 | 1973 |
| 4 | 985 | 38·9 | 825 | 1489 |
| 3 | 656 | 18·6 | 585 | 1278 |
| 2 | 400 | 7·3 | 373 | 1153 |
| 1 | 186 | 1·7 | 180 | 1066 |
| 0 | 0 | 0 | 0 | 1000 |

| $\gamma = 3{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 5° | 1547 | 83·2 | 1139 | 2126 |
| 4 | 1002 | 39·8 | 831 | 1522 |
| 3 | 662 | 18·8 | 588 | 1293 |
| 2 | 402 | 7·4 | 374 | 1159 |
| 1 | 186 | 1·7 | 180 | 1068 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 165 | 1·4 | 170 | 947 |
| 2 | 314 | 5·3 | 331 | 904 |
| 3 | 451 | 11·3 | 486 | 868 |
| 4 | 578 | 19·0 | 635 | 838 |
| 5 | 697 | 28·3 | 779 | 811 |

XVI. (*continued*).

| $\gamma = 3{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 6° | 808 | 39·1 | 919 | 788 |
| 7 | 914 | 51·1 | 1056 | 768 |
| 8 | 1014 | 64·3 | 1190 | 750 |
| 9 | 1110 | 78·6 | 1321 | 734 |
| 10 | 1202 | 94·0 | 1449 | 719 |
| 11 | 1291 | 110·4 | 1575 | 706 |
| 12 | 1376 | 127·8 | 1700 | 694 |
| 13 | 1459 | 146·1 | 1823 | 683 |
| 14 | 1539 | 165·4 | 1945 | 673 |
| 15 | 1617 | 185·5 | 2065 | 664 |
| 16 | 1693 | 206·6 | 2185 | 655 |
| 17 | 1767 | 228·5 | 2303 | 647 |
| 18 | 1839 | 251·3 | 2421 | 640 |
| 19 | 1910 | 275·0 | 2538 | 634 |
| 20 | 1979 | 299·5 | 2655 | 628 |
| 21 | 2047 | 325·0 | 2771 | 622 |
| 22 | 2114 | 351·4 | 2887 | 617 |
| 23 | 2180 | 378·7 | 3004 | 612 |
| 24 | 2245 | 406·9 | 3120 | 608 |
| 25 | 2309 | 436·1 | 3236 | 604 |
| 26 | 2373 | 466·3 | 3352 | 600 |
| 27 | 2435 | 497·4 | 3469 | 597 |
| 28 | 2497 | 529·6 | 3586 | 594 |
| 29 | 2558 | 562·9 | 3704 | 591 |
| 30 | 2619 | 597·3 | 3822 | 589 |
| 31 | 2679 | 632·8 | 3941 | 587 |
| 32 | 2739 | 669·5 | 4061 | 585 |
| 33 | 2799 | 707·4 | 4182 | 583 |
| 34 | 2858 | 746·5 | 4304 | 582 |
| 35 | 2917 | 787·0 | 4427 | 580 |
| 36 | 2975 | 828·9 | 4551 | 579 |
| 37 | 3034 | 872·1 | 4677 | 579 |
| 38 | 3092 | 916·9 | 4804 | 578 |
| 39 | 3150 | 963·2 | 4933 | 578 |
| 40 | 3209 | 1011 | 5063 | 577 |
| 41 | 3267 | 1061 | 5196 | 577 |
| 42 | 3325 | 1112 | 5330 | 577 |
| 43 | 3383 | 1166 | 5467 | 578 |
| 44 | 3441 | 1221 | 5606 | 578 |
| 45 | 3500 | 1278 | 5748 | 579 |

| $\gamma = 3{\cdot}5$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 4° | 1021 | 40·8 | 838 | 1562 |
| 3 | 668 | 19·1 | 590 | 1308 |
| 2 | 404 | 7·4 | 375 | 1165 |
| 1 | 187 | 1·7 | 180 | 1070 |
| 0 | 0 | 0 | 0 | 1000 |

| $\gamma = 3{\cdot}6$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 4° | 1041 | 41·9 | 846 | 1605 |
| 3 | 675 | 19·3 | 593 | 1323 |
| 2 | 406 | 7·5 | 376 | 1172 |
| 1 | 187 | 1·7 | 181 | 1072 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 165 | 1·4 | 170 | 944 |
| 2 | 313 | 5·3 | 330 | 899 |
| 3 | 448 | 11·2 | 484 | 862 |
| 4 | 573 | 18·8 | 632 | 831 |
| 5 | 689 | 27·9 | 775 | 804 |
| 6 | 799 | 38·5 | 914 | 780 |
| 7 | 902 | 50·3 | 1049 | 760 |
| 8 | 1001 | 63·2 | 1181 | 741 |
| 9 | 1094 | 77·2 | 1311 | 725 |
| 10 | 1184 | 92·2 | 1438 | 710 |
| 11 | 1271 | 108·2 | 1562 | 697 |
| 12 | 1354 | 125·1 | 1685 | 685 |
| 13 | 1434 | 143·0 | 1807 | 674 |
| 14 | 1512 | 161·7 | 1927 | 664 |
| 15 | 1588 | 181·3 | 2045 | 654 |
| 16 | 1662 | 201·7 | 2163 | 646 |
| 17 | 1734 | 223·0 | 2280 | 638 |
| 18 | 1804 | 245·2 | 2396 | 631 |
| 19 | 1872 | 268·1 | 2512 | 624 |
| 20 | 1940 | 292·0 | 2627 | 618 |
| 21 | 2006 | 316·7 | 2741 | 612 |
| 22 | 2071 | 342·2 | 2856 | 607 |
| 23 | 2135 | 368·7 | 2970 | 603 |
| 24 | 2198 | 396·0 | 3084 | 598 |
| 25 | 2260 | 424·3 | 3198 | 594 |

XVI. (*continued*).

$\gamma = 3{\cdot}6$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 26° | 2321 | 453·5 | 3313 | 591 |
| 27 | 2381 | 483·7 | 3428 | 587 |
| 28 | 2441 | 514·9 | 3543 | 584 |
| 29 | 2501 | 547·1 | 3659 | 582 |
| 30 | 2559 | 580·3 | 3775 | 579 |
| 31 | 2618 | 614·7 | 3892 | 577 |
| 32 | 2675 | 650·1 | 4010 | 575 |
| 33 | 2733 | 686·8 | 4129 | 573 |
| 34 | 2790 | 724·7 | 4249 | 572 |
| 35 | 2847 | 763·8 | 4370 | 571 |
| 36 | 2904 | 804·2 | 4492 | 569 |
| 37 | 2960 | 846·0 | 4616 | 569 |
| 38 | 3017 | 889·3 | 4741 | 568 |
| 39 | 3073 | 934·0 | 4867 | 568 |
| 40 | 3129 | 980·3 | 4995 | 567 |
| 41 | 3185 | 1028 | 5126 | 567 |
| 42 | 3241 | 1078 | 5258 | 567 |
| 43 | 3298 | 1129 | 5392 | 568 |
| 44 | 3354 | 1183 | 5529 | 568 |
| 45 | 3410 | 1238 | 5668 | 568 |

$\gamma = 3{\cdot}7$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 4° | 1063 | 43·1 | 854 | 1654 |
| 3 | 682 | 19·6 | 596 | 1340 |
| 2 | 408 | 7·5 | 377 | 1178 |
| 1 | 187 | 1·7 | 181 | 1075 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 3{\cdot}8$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 4° | 1086 | 44·4 | 862 | 1710 |
| 3 | 689 | 19·8 | 599 | 1357 |
| 2 | 410 | 7·6 | 378 | 1185 |
| 1 | 188 | 1·7 | 181 | 1077 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 3{\cdot}8$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 1° | 164 | 1·4 | 169 | 941 |
| 2 | 311 | 5·2 | 329 | 895 |
| 3 | 445 | 11·1 | 482 | 856 |
| 4 | 568 | 18·6 | 629 | 824 |
| 5 | 682 | 27·6 | 771 | 797 |
| 6 | 790 | 37·9 | 909 | 773 |
| 7 | 891 | 49·5 | 1042 | 752 |
| 8 | 987 | 62·1 | 1173 | 733 |
| 9 | 1079 | 75·8 | 1301 | 717 |
| 10 | 1167 | 90·5 | 1426 | 702 |
| 11 | 1251 | 106·1 | 1550 | 688 |
| 12 | 1332 | 122·6 | 1671 | 676 |
| 13 | 1411 | 140·0 | 1791 | 665 |
| 14 | 1487 | 158·2 | 1910 | 655 |
| 15 | 1560 | 177·3 | 2027 | 645 |
| 16 | 1632 | 197·2 | 2143 | 637 |
| 17 | 1702 | 217·9 | 2258 | 629 |
| 18 | 1770 | 239·4 | 2372 | 622 |
| 19 | 1837 | 261·7 | 2486 | 615 |
| 20 | 1902 | 284·9 | 2600 | 609 |
| 21 | 1967 | 308·9 | 2713 | 604 |
| 22 | 2030 | 333·7 | 2825 | 598 |
| 23 | 2092 | 359·4 | 2938 | 594 |
| 24 | 2153 | 385·9 | 3050 | 589 |
| 25 | 2213 | 413·3 | 3163 | 585 |
| 26 | 2272 | 441·7 | 3276 | 582 |
| 27 | 2331 | 470·9 | 3389 | 578 |
| 28 | 2389 | 501·2 | 3502 | 575 |
| 29 | 2447 | 532·4 | 3616 | 573 |
| 30 | 2503 | 564·6 | 3731 | 570 |
| 31 | 2560 | 597·9 | 3846 | 568 |
| 32 | 2616 | 632·2 | 3962 | 566 |
| 33 | 2672 | 667·7 | 4079 | 564 |
| 34 | 2727 | 704·4 | 4197 | 563 |
| 35 | 2782 | 742·2 | 4316 | 561 |
| 36 | 2837 | 781·4 | 4436 | 560 |
| 37 | 2892 | 821·9 | 4558 | 559 |
| 38 | 2946 | 863·7 | 4681 | 559 |
| 39 | 3001 | 907·0 | 4805 | 558 |
| 40 | 3055 | 951·8 | 4932 | 558 |
| 41 | 3109 | 998·2 | 5060 | 558 |
| 42 | 3164 | 1046 | 5190 | 558 |
| 43 | 3218 | 1096 | 5322 | 558 |
| 44 | 3272 | 1148 | 5456 | 558 |
| 45 | 3327 | 1201 | 5593 | 559 |

XVI. (*continued*).

$\gamma = 3{\cdot}9$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 4° | 1113 | 45·9 | 871 | 1774 |
| 3 | 696 | 20·1 | 602 | 1375 |
| 2 | 412 | 7·6 | 379 | 1192 |
| 1 | 188 | 1·7 | 181 | 1079 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 4{\cdot}0$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 4° | 1142 | 47·6 | 881 | 1848 |
| 3 | 704 | 20·4 | 605 | 1394 |
| 2 | 414 | 7·7 | 380 | 1199 |
| 1 | 188 | 1·7 | 181 | 1082 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 164 | 1·4 | 169 | 939 |
| 2 | 309 | 5·2 | 329 | 890 |
| 3 | 442 | 10·9 | 481 | 851 |
| 4 | 563 | 18·4 | 626 | 818 |
| 5 | 676 | 27·2 | 767 | 790 |
| 6 | 781 | 37·4 | 903 | 766 |
| 7 | 881 | 48·7 | 1036 | 744 |
| 8 | 975 | 61·1 | 1165 | 725 |
| 9 | 1064 | 74·5 | 1292 | 709 |
| 10 | 1150 | 88·8 | 1416 | 694 |
| 11 | 1233 | 104·1 | 1538 | 680 |
| 12 | 1312 | 120·2 | 1658 | 668 |
| 13 | 1388 | 137·2 | 1776 | 657 |
| 14 | 1462 | 154·9 | 1893 | 646 |
| 15 | 1534 | 173·5 | 2009 | 637 |
| 16 | 1604 | 192·9 | 2123 | 629 |
| 17 | 1672 | 213·0 | 2237 | 621 |
| 18 | 1739 | 234·0 | 2350 | 613 |
| 19 | 1804 | 255·7 | 2462 | 607 |
| 20 | 1867 | 278·2 | 2574 | 601 |
| 21 | 1930 | 301·6 | 2685 | 595 |
| 22 | 1991 | 325·7 | 2796 | 590 |
| 23 | 2051 | 350·7 | 2907 | 585 |
| 24 | 2110 | 376·4 | 3018 | 581 |
| 25 | 2169 | 403·1 | 3129 | 577 |

$\gamma = 4{\cdot}0$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 26° | 2226 | 430·6 | 3241 | 573 |
| 27 | 2283 | 459·0 | 3352 | 570 |
| 28 | 2340 | 488·3 | 3464 | 567 |
| 29 | 2396 | 518·6 | 3576 | 564 |
| 30 | 2451 | 549·9 | 3689 | 562 |
| 31 | 2506 | 582·2 | 3802 | 559 |
| 32 | 2560 | 615·5 | 3917 | 557 |
| 33 | 2614 | 649·9 | 4032 | 556 |
| 34 | 2668 | 685·5 | 4148 | 554 |
| 35 | 2721 | 722·2 | 4265 | 553 |
| 36 | 2774 | 760·1 | 4384 | 552 |
| 37 | 2827 | 799·4 | 4503 | 551 |
| 38 | 2880 | 839·9 | 4624 | 550 |
| 39 | 2933 | 881·9 | 4747 | 550 |
| 40 | 2986 | 925·3 | 4871 | 549 |
| 41 | 3038 | 970·2 | 4997 | 549 |
| 42 | 3091 | 1017 | 5125 | 549 |
| 43 | 3144 | 1065 | 5255 | 549 |
| 44 | 3196 | 1115 | 5387 | 550 |
| 45 | 3249 | 1167 | 5522 | 550 |

$\gamma = 4{\cdot}2$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 4° | 1212 | 51·7 | 903 | 2047 |
| 3 | 720 | 21·1 | 611 | 1436 |
| 2 | 419 | 7·8 | 382 | 1214 |
| 1 | 189 | 1·7 | 182 | 1087 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 4{\cdot}4$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 3° | 738 | 21·8 | 618 | 1484 |
| 2 | 423 | 7·9 | 384 | 1230 |
| 1 | 190 | 1·7 | 182 | 1091 |
| 0 | 0 | 0 | 0 | 1000 |

XVI. (*continued*).

| $\gamma = 4{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 1° | 163 | 1·4 | 169 | 933 |
| 2 | 306 | 5·1 | 327 | 882 |
| 3 | 435 | 10·8 | 477 | 840 |
| 4 | 554 | 18·0 | 621 | 806 |
| 5 | 663 | 26·5 | 759 | 777 |
| 6 | 765 | 36·3 | 893 | 752 |
| 7 | 860 | 47·2 | 1024 | 730 |
| 8 | 951 | 59·2 | 1150 | 711 |
| 9 | 1037 | 72·0 | 1274 | 694 |
| 10 | 1119 | 85·7 | 1396 | 679 |
| 11 | 1198 | 100·3 | 1515 | 665 |
| 12 | 1273 | 115·7 | 1632 | 652 |
| 13 | 1346 | 131·9 | 1748 | 641 |
| 14 | 1417 | 148·8 | 1862 | 631 |
| 15 | 1485 | 166·5 | 1975 | 622 |
| 16 | 1552 | 185·0 | 2087 | 613 |
| 17 | 1617 | 204·1 | 2197 | 605 |
| 18 | 1680 | 224·0 | 2307 | 598 |
| 19 | 1741 | 244·7 | 2417 | 591 |
| 20 | 1802 | 266·1 | 2526 | 585 |
| 21 | 1861 | 288·2 | 2634 | 580 |
| 22 | 1919 | 311·1 | 2742 | 574 |
| 23 | 1976 | 334·7 | 2850 | 570 |
| 24 | 2032 | 359·1 | 2958 | 565 |
| 25 | 2088 | 384·3 | 3066 | 561 |
| 26 | 2142 | 410·4 | 3175 | 558 |
| 27 | 2196 | 437·3 | 3283 | 554 |
| 28 | 2250 | 465·0 | 3392 | 551 |
| 29 | 2302 | 493·6 | 3501 | 548 |
| 30 | 2355 | 523·2 | 3611 | 546 |
| 31 | 2406 | 553·7 | 3721 | 544 |
| 32 | 2458 | 585·2 | 3832 | 542 |
| 33 | 2509 | 617·7 | 3944 | 540 |
| 34 | 2559 | 651·3 | 4057 | 538 |
| 35 | 2610 | 685·9 | 4171 | 537 |
| 36 | 2660 | 721·7 | 4286 | 536 |
| 37 | 2710 | 758·7 | 4402 | 535 |
| 38 | 2760 | 797·0 | 4519 | 534 |
| 39 | 2810 | 836·6 | 4638 | 534 |
| 40 | 2859 | 877·5 | 4759 | 533 |
| 41 | 2909 | 919·9 | 4881 | 533 |
| 42 | 2958 | 963·7 | 5006 | 533 |
| 43 | 3008 | 1009 | 5132 | 533 |
| 44 | 3058 | 1056 | 5260 | 533 |
| 45 | 3107 | 1105 | 5391 | 534 |

| $\gamma = 4{\cdot}6$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 3° | 758 | 22·6 | 626 | 1538 |
| 2 | 428 | 8·0 | 386 | 1246 |
| 1 | 191 | 1·7 | 183 | 1096 |
| 0 | 0 | 0 | 0 | 1000 |

| $\gamma = 4{\cdot}8$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| 3° | 780 | 23·5 | 634 | 1601 |
| 2 | 433 | 8·1 | 388 | 1263 |
| 1 | 192 | 1·7 | 183 | 1103 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 162 | 1·4 | 168 | 928 |
| 2 | 303 | 5·1 | 325 | 874 |
| 3 | 429 | 10·6 | 474 | 830 |
| 4 | 545 | 17·6 | 616 | 795 |
| 5 | 650 | 25·9 | 752 | 765 |
| 6 | 749 | 35·4 | 884 | 739 |
| 7 | 841 | 45·9 | 1012 | 717 |
| 8 | 929 | 57·4 | 1136 | 697 |
| 9 | 1011 | 69·7 | 1258 | 680 |
| 10 | 1090 | 82·9 | 1377 | 665 |
| 11 | 1166 | 96·9 | 1493 | 651 |
| 12 | 1238 | 111·7 | 1608 | 638 |
| 13 | 1308 | 127·2 | 1721 | 627 |
| 14 | 1376 | 143·4 | 1833 | 617 |
| 15 | 1441 | 160·3 | 1943 | 608 |
| 16 | 1504 | 177·9 | 2052 | 599 |
| 17 | 1566 | 196·2 | 2161 | 591 |
| 18 | 1626 | 215·1 | 2268 | 584 |
| 19 | 1685 | 234·8 | 2375 | 577 |
| 20 | 1743 | 255·2 | 2481 | 571 |
| 21 | 1799 | 276·2 | 2587 | 565 |
| 22 | 1854 | 298·0 | 2693 | 560 |
| 23 | 1909 | 320·5 | 2798 | 555 |
| 24 | 1962 | 343·7 | 2903 | 551 |
| 25 | 2015 | 367·7 | 3009 | 547 |
| 26 | 2067 | 392·5 | 3114 | 544 |
| 27 | 2118 | 418·0 | 3220 | 540 |
| 28 | 2169 | 444·4 | 3326 | 537 |
| 29 | 2219 | 471·6 | 3432 | 534 |
| 30 | 2268 | 499·6 | 3539 | 532 |

XVI. (*continued*).

$\gamma = 4{\cdot}8$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 31° | 2317 | 528·6 | 3647 | 530 |
| 32 | 2366 | 558·4 | 3755 | 528 |
| 33 | 2414 | 589·3 | 3864 | 526 |
| 34 | 2463 | 621·1 | 3974 | 524 |
| 35 | 2510 | 654·0 | 4085 | 523 |
| 36 | 2558 | 687·9 | 4196 | 522 |
| 37 | 2605 | 723·0 | 4310 | 521 |
| 38 | 2653 | 759·3 | 4424 | 520 |
| 39 | 2700 | 796·8 | 4540 | 519 |
| 40 | 2747 | 835·5 | 4657 | 519 |
| 41 | 2794 | 875·7 | 4776 | 519 |
| 42 | 2841 | 917·2 | 4897 | 519 |
| 43 | 2888 | 960·2 | 5020 | 519 |
| 44 | 2935 | 1005 | 5145 | 519 |
| 45 | 2982 | 1051 | 5272 | 519 |

$\gamma = 5{\cdot}0$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 3° | 804 | 24·6 | 643 | 1676 |
| 2 | 438 | 8·3 | 390 | 1282 |
| 1 | 193 | 1·7 | 183 | 1107 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 5{\cdot}2$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| ° | | | | |
| 3·5 | 1239 | 49·1 | 839 | 2824 |
| 3·0 | 833 | 25·8 | 652 | 1768 |
| 2·5 | 609 | 15·0 | 513 | 1466 |
| 2·0 | 444 | 8·4 | 393 | 1301 |
| 1·0 | 193 | 1·8 | 184 | 1112 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 161 | 1·4 | 168 | 923 |
| 2 | 300 | 5·0 | 323 | 866 |
| 3 | 424 | 10·4 | 471 | 820 |
| 4 | 536 | 17·2 | 611 | 784 |
| 5 | 639 | 25·3 | 745 | 753 |

$\gamma = 5{\cdot}2$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 6° | 734 | 34·5 | 875 | 727 |
| 7 | 824 | 44·7 | 1001 | 705 |
| 8 | 908 | 55·7 | 1123 | 685 |
| 9 | 988 | 67·7 | 1242 | 667 |
| 10 | 1064 | 80·4 | 1359 | 652 |
| 11 | 1136 | 93·8 | 1473 | 638 |
| 12 | 1206 | 108·0 | 1586 | 626 |
| 13 | 1273 | 122·8 | 1697 | 614 |
| 14 | 1338 | 138·4 | 1806 | 604 |
| 15 | 1400 | 154·6 | 1914 | 595 |
| 16 | 1461 | 171·4 | 2021 | 586 |
| 17 | 1520 | 188·9 | 2127 | 578 |
| 18 | 1578 | 207·1 | 2232 | 571 |
| 19 | 1634 | 225·9 | 2336 | 564 |
| 20 | 1689 | 245·4 | 2440 | 558 |
| 21 | 1743 | 265·5 | 2544 | 553 |
| 22 | 1796 | 286·3 | 2647 | 548 |
| 23 | 1847 | 307·8 | 2750 | 543 |
| 24 | 1898 | 329·9 | 2853 | 538 |
| 25 | 1949 | 352·8 | 2956 | 534 |
| 26 | 1998 | 376·4 | 3059 | 531 |
| 27 | 2047 | 400·8 | 3162 | 528 |
| 28 | 2095 | 425·9 | 3265 | 524 |
| 29 | 2143 | 451·8 | 3369 | 522 |
| 30 | 2190 | 478·6 | 3473 | 519 |
| 31 | 2237 | 506·1 | 3578 | 517 |
| 32 | 2284 | 534·6 | 3684 | 515 |
| 33 | 2330 | 564·0 | 3790 | 513 |
| 34 | 2375 | 594·3 | 3897 | 512 |
| 35 | 2421 | 625·6 | 4006 | 510 |
| 36 | 2466 | 657·9 | 4115 | 509 |
| 37 | 2511 | 691·3 | 4225 | 508 |
| 38 | 2556 | 725·8 | 4337 | 507 |
| 39 | 2601 | 761·4 | 4450 | 507 |
| 40 | 2646 | 798·3 | 4564 | 506 |
| 41 | 2691 | 836·5 | 4681 | 506 |
| 42 | 2735 | 876·0 | 4798 | 506 |
| 43 | 2780 | 916·8 | 4918 | 506 |
| 44 | 2825 | 959·2 | 5040 | 506 |
| 45 | 2869 | 1003 | 5164 | 506 |

XVI. (*continued*).

$\gamma = 5{\cdot}4$

| $\phi$ | (x) | (y) | (r) | (v) |
|---|---|---|---|---|
| 3°·0 | 866 | 27·2 | 664 | 1884 |
| 2·5 | 623 | 15·4 | 518 | 1508 |
| 2·0 | 450 | 8·6 | 395 | 1322 |
| 1·0 | 194 | 1·8 | 184 | 1117 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 5{\cdot}6$

| $\phi$ | (x) | (y) | (r) | (v) |
|---|---|---|---|---|
| 3°·0 | 907 | 29·0 | 677 | 2037 |
| 2·5 | 637 | 15·9 | 523 | 1556 |
| 2·0 | 456 | 8·7 | 398 | 1344 |
| 1·0 | 195 | 1·8 | 184 | 1123 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 160 | 1·4 | 167 | 918 |
| 2 | 297 | 4·9 | 322 | 858 |
| 3 | 418 | 10·2 | 467 | 811 |
| 4 | 528 | 16·9 | 606 | 774 |
| 5 | 628 | 24·7 | 738 | 742 |
| 6 | 721 | 33·7 | 866 | 716 |
| 7 | 807 | 43·5 | 990 | 693 |
| 8 | 889 | 54·2 | 1110 | 673 |
| 9 | 966 | 65·7 | 1227 | 656 |
| 10 | 1039 | 78·0 | 1342 | 640 |
| 11 | 1109 | 90·9 | 1454 | 626 |
| 12 | 1176 | 104·6 | 1565 | 614 |
| 13 | 1240 | 118·9 | 1673 | 602 |
| 14 | 1303 | 133·8 | 1781 | 592 |
| 15 | 1363 | 149·4 | 1886 | 583 |
| 16 | 1421 | 165·5 | 1991 | 574 |
| 17 | 1478 | 182·3 | 2095 | 566 |
| 18 | 1533 | 199·8 | 2198 | 559 |
| 19 | 1587 | 217·8 | 2300 | 553 |
| 20 | 1640 | 236·5 | 2402 | 547 |
| 21 | 1691 | 255·7 | 2503 | 541 |
| 22 | 1742 | 275·7 | 2604 | 536 |
| 23 | 1792 | 296·2 | 2705 | 531 |
| 24 | 1840 | 317·5 | 2806 | 527 |
| 25 | 1888 | 339·4 | 2906 | 523 |

$\gamma = 5{\cdot}6$

| $\phi$ | (x) | (y) | (r) | (v) |
|---|---|---|---|---|
| 26° | 1936 | 362·0 | 3007 | 519 |
| 27 | 1982 | 385·3 | 3108 | 516 |
| 28 | 2029 | 409·3 | 3209 | 513 |
| 29 | 2074 | 434·1 | 3311 | 510 |
| 30 | 2119 | 459·6 | 3413 | 508 |
| 31 | 2164 | 486·0 | 3515 | 505 |
| 32 | 2209 | 513·2 | 3619 | 503 |
| 33 | 2253 | 541·2 | 3722 | 502 |
| 34 | 2296 | 570·2 | 3827 | 500 |
| 35 | 2340 | 600·1 | 3933 | 499 |
| 36 | 2383 | 630·9 | 4040 | 497 |
| 37 | 2426 | 662·8 | 4148 | 496 |
| 38 | 2469 | 695·8 | 4257 | 496 |
| 39 | 2512 | 729·8 | 4367 | 495 |
| 40 | 2555 | 765 0 | 4479 | 494 |
| 41 | 2597 | 801·4 | 4592 | 494 |
| 42 | 2640 | 839·1 | 4708 | 494 |
| 43 | 2682 | 878·1 | 4825 | 494 |
| 44 | 2725 | 918·6 | 4943 | 494 |
| 45 | 2768 | 960·5 | 5064 | 494 |

$\gamma = 5{\cdot}8$

| $\phi$ | (x) | (y) | (r) | (v) |
|---|---|---|---|---|
| 3°·0 | 958 | 31·3 | 692 | 2258 |
| 2·5 | 653 | 16·4 | 529 | 1611 |
| 2·0 | 462 | 8·9 | 400 | 1367 |
| 1·0 | 196 | 1·8 | 185 | 1128 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 6{\cdot}0$

| $\phi$ | (x) | (y) | (r) | (v) |
|---|---|---|---|---|
| 3°·0 | 1029 | 34·5 | 711 | 2621 |
| 2·5 | 670 | 17·0 | 535 | 1675 |
| 2·0 | 469 | 9·1 | 403 | 1392 |
| 1·0 | 197 | 1·8 | 185 | 1134 |
| 0 | 0 | 0 | 0 | 1000 |

XVI. (*continued*).

| $\gamma = 6{\cdot}0$ | | | | | $\gamma = 6{\cdot}2$ | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) | $\phi$ | (X) | (Y) | (T) | (V) |
| 1° | 159 | 1·3 | 167 | 913 | ° 2·5 | 689 | 17·7 | 542 | 1749 |
| 2 | 294 | 4·9 | 320 | 850 | 2·0 | 476 | 9·3 | 406 | 1420 |
| 3 | 413 | 10·0 | 464 | 802 | 1·0 | 198 | 1·8 | 186 | 1140 |
| 4 | 520 | 16·6 | 601 | 764 | 0 | 0 | 0 | 0 | 1000 |
| 5 | 618 | 24·2 | 732 | 732 | | | | | |
| 6 | 708 | 32·9 | 858 | 705 | | | | | |
| 7 | 792 | 42·4 | 980 | 682 | | | | | |
| 8 | 870 | 52·8 | 1098 | 662 | | | | | |
| 9 | 945 | 63·9 | 1213 | 645 | | | | | |
| 10 | 1016 | 75·8 | 1326 | 629 | | | | | |
| 11 | 1083 | 88·3 | 1437 | 615 | | | | | |
| 12 | 1148 | 101·4 | 1545 | 603 | | | | | |
| 13 | 1210 | 115·2 | 1652 | 591 | | | | | |
| 14 | 1270 | 129·6 | 1757 | 581 | | | | | |
| 15 | 1328 | 144·6 | 1861 | 572 | | | | | |
| 16 | 1384 | 160·2 | 1963 | 563 | | | | | |
| 17 | 1439 | 176·3 | 2065 | 555 | | | | | |
| 18 | 1492 | 193·1 | 2166 | 548 | | | | | |
| 19 | 1544 | 210·4 | 2267 | 542 | | | | | |
| 20 | 1594 | 228·4 | 2366 | 536 | | | | | |
| 21 | 1644 | 246·9 | 2466 | 530 | | | | | |
| 22 | 1692 | 266·0 | 2565 | 525 | | | | | |
| 23 | 1740 | 285·8 | 2663 | 520 | | | | | |
| 24 | 1787 | 306·1 | 2762 | 516 | | | | | |
| 25 | 1833 | 327·2 | 2860 | 512 | | | | | |
| 26 | 1879 | 348·8 | 2959 | 509 | | | | | |
| 27 | 1923 | 371·2 | 3058 | 505 | | | | | |
| 28 | 1968 | 394·2 | 3157 | 502 | | | | | |
| 29 | 2011 | 418·0 | 3257 | 499 | | | | | |
| 30 | 2055 | 442·5 | 3357 | 497 | | | | | |
| 31 | 2098 | 467·8 | 3457 | 495 | | | | | |
| 32 | 2140 | 493·8 | 3558 | 493 | | | | | |
| 33 | 2182 | 520·7 | 3660 | 491 | | | | | |
| 34 | 2224 | 548·5 | 3762 | 489 | | | | | |
| 35 | 2266 | 577·1 | 3866 | 488 | | | | | |
| 36 | 2307 | 606·7 | 3970 | 487 | | | | | |
| 37 | 2349 | 637·2 | 4076 | 486 | | | | | |
| 38 | 2390 | 668·7 | 4183 | 485 | | | | | |
| 39 | 2431 | 701·3 | 4291 | 484 | | | | | |
| 40 | 2472 | 735·0 | 4400 | 484 | | | | | |
| 41 | 2512 | 769·9 | 4511 | 484 | | | | | |
| 42 | 2553 | 806·0 | 4624 | 483 | | | | | |
| 43 | 2594 | 843·3 | 4738 | 483 | | | | | |
| 44 | 2635 | 882·0 | 4854 | 483 | | | | | |
| 45 | 2676 | 922·1 | 4973 | 484 | | | | | |

| $\gamma = 6{\cdot}4$ | | | | |
|---|---|---|---|---|
| $\phi$ | (X) | (Y) | (T) | (V) |
| ° 2·5 | 712 | 18·5 | 550 | 1839 |
| 2·0 | 483 | 9·5 | 409 | 1449 |
| 1·0 | 199 | 1·8 | 186 | 1146 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 158 | 1·3 | 166 | 908 |
| 2 | 292 | 4·8 | 319 | 843 |
| 3 | 408 | 9·9 | 462 | 794 |
| 4 | 513 | 16·3 | 597 | 755 |
| 5 | 608 | 23·7 | 726 | 722 |
| 6 | 695 | 32·1 | 850 | 695 |
| 7 | 777 | 41·4 | 970 | 672 |
| 8 | 853 | 51·5 | 1087 | 652 |
| 9 | 925 | 62·3 | 1200 | 634 |
| 10 | 994 | 73·7 | 1311 | 619 |
| 11 | 1059 | 85·8 | 1420 | 605 |
| 12 | 1122 | 98·5 | 1526 | 592 |
| 13 | 1182 | 111·8 | 1631 | 581 |
| 14 | 1240 | 125·7 | 1734 | 571 |
| 15 | 1296 | 140·2 | 1836 | 562 |
| 16 | 1350 | 155·2 | 1937 | 553 |
| 17 | 1402 | 170·8 | 2037 | 545 |
| 18 | 1454 | 186·9 | 2136 | 538 |
| 19 | 1504 | 203·7 | 2235 | 532 |
| 20 | 1552 | 220·9 | 2333 | 526 |
| 21 | 1600 | 238·8 | 2430 | 520 |
| 22 | 1647 | 257·2 | 2527 | 515 |
| 23 | 1693 | 276·2 | 2624 | 511 |
| 24 | 1738 | 295·8 | 2721 | 506 |
| 25 | 1782 | 316·0 | 2818 | 502 |
| 26 | 1826 | 336·9 | 2914 | 499 |
| 27 | 1869 | 358·4 | 3011 | 495 |
| 28 | 1912 | 380·5 | 3108 | 492 |
| 29 | 1954 | 403·4 | 3206 | 490 |
| 30 | 1995 | 426·9 | 3304 | 487 |

XVI. (*continued*).

$\gamma = 6{\cdot}4$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 31° | 2036 | 451·2 | 3402 | 485 |
| 32 | 2077 | 476·2 | 3501 | 483 |
| 33 | 2118 | 502·1 | 3601 | 481 |
| 34 | 2158 | 528·7 | 3702 | 480 |
| 35 | 2198 | 556·2 | 3803 | 478 |
| 36 | 2238 | 584·6 | 3905 | 477 |
| 37 | 2278 | 613·9 | 4009 | 476 |
| 38 | 2317 | 644·2 | 4114 | 475 |
| 39 | 2356 | 675·5 | 4219 | 475 |
| 40 | 2396 | 707·9 | 4327 | 474 |
| 41 | 2435 | 741·3 | 4435 | 474 |
| 42 | 2474 | 776·0 | 4546 | 473 |
| 43 | 2513 | 811·8 | 4658 | 473 |
| 44 | 2552 | 848·9 | 4772 | 474 |
| 45 | 2591 | 887·4 | 4888 | 474 |

$\gamma = 6{\cdot}6$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 2°·5 | 737 | 19·4 | 55·8 | 1951 |
| 2°·0 | 491 | 9·7 | 41·2 | 1481 |
| 1°·0 | 200 | 1·8 | 18·7 | 1152 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 6{\cdot}8$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 2°·5 | 768 | 20·6 | 567 | 2097 |
| 2°·0 | 500 | 9·9 | 415 | 1516 |
| 1°·0 | 201 | 1·8 | 187 | 1158 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 157 | 1·3 | 166 | 904 |
| 2 | 289 | 4·7 | 317 | 836 |
| 3 | 403 | 9·7 | 459 | 786 |
| 4 | 505 | 16·0 | 592 | 746 |
| 5 | 598 | 23·2 | 720 | 713 |

$\gamma = 6{\cdot}8$

| $\phi$ | (x) | (y) | (T) | (v) |
|---|---|---|---|---|
| 6° | 684 | 31·5 | 843 | 686 |
| 7 | 763 | 40·5 | 961 | 663 |
| 8 | 837 | 50·2 | 1076 | 642 |
| 9 | 907 | 60·7 | 1188 | 625 |
| 10 | 973 | 71·8 | 1297 | 609 |
| 11 | 1037 | 83·5 | 1404 | 595 |
| 12 | 1097 | 95·8 | 1508 | 583 |
| 13 | 1155 | 108·7 | 1612 | 572 |
| 14 | 1211 | 122·1 | 1713 | 561 |
| 15 | 1265 | 136·1 | 1814 | 552 |
| 16 | 1318 | 150·6 | 1913 | 544 |
| 17 | 1368 | 165·7 | 2011 | 536 |
| 18 | 1418 | 181·3 | 2108 | 529 |
| 19 | 1466 | 197·4 | 2205 | 522 |
| 20 | 1513 | 214·1 | 2301 | 516 |
| 21 | 1559 | 231·3 | 2397 | 511 |
| 22 | 1604 | 249·0 | 2492 | 506 |
| 23 | 1649 | 267·4 | 2587 | 501 |
| 24 | 1692 | 286·3 | 2682 | 497 |
| 25 | 1735 | 305·8 | 2777 | 493 |
| 26 | 1777 | 325·9 | 2872 | 490 |
| 27 | 1819 | 346·6 | 2968 | 486 |
| 28 | 1860 | 367·9 | 3063 | 483 |
| 29 | 1900 | 389·9 | 3159 | 481 |
| 30 | 1940 | 412·6 | 3255 | 478 |
| 31 | 1980 | 436·0 | 3351 | 476 |
| 32 | 2019 | 460·1 | 3449 | 474 |
| 33 | 2058 | 485·0 | 3546 | 472 |
| 34 | 2097 | 510·7 | 3645 | 471 |
| 35 | 2136 | 537·1 | 3745 | 469 |
| 36 | 2174 | 564·5 | 3845 | 468 |
| 37 | 2212 | 592·7 | 3947 | 467 |
| 38 | 2250 | 621·8 | 4049 | 466 |
| 39 | 2288 | 652·0 | 4153 | 465 |
| 40 | 2326 | 683·1 | 4258 | 465 |
| 41 | 2363 | 715·3 | 4365 | 465 |
| 42 | 2401 | 748·6 | 4473 | 464 |
| 43 | 2439 | 783·1 | 4583 | 464 |
| 44 | 2476 | 818·8 | 4695 | 464 |
| 45 | 2514 | 855·8 | 4809 | 465 |

XVI. (*continued*).

$\gamma = 7{\cdot}0$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 2°·5 | 806 | 22·0 | 578 | 2299 |
| 2·0 | 509 | 10·2 | 418 | 1555 |
| 1·0 | 202 | 1·9 | 188 | 1165 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 7{\cdot}2$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 2°·5 | 856 | 23·9 | 592 | 2611 |
| 2·0 | 519 | 10·4 | 422 | 1598 |
| 1·0 | 203 | 1·9 | 188 | 1171 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 156 | 1·3 | 165 | 899 |
| 2 | 286 | 4·7 | 316 | 830 |
| 3 | 399 | 9·6 | 456 | 778 |
| 4 | 499 | 15·7 | 588 | 737 |
| 5 | 589 | 22·8 | 714 | 704 |
| 6 | 672 | 30·8 | 835 | 677 |
| 7 | 750 | 39·6 | 952 | 653 |
| 8 | 822 | 49·1 | 1065 | 633 |
| 9 | 890 | 59·2 | 1176 | 616 |
| 10 | 954 | 70·0 | 1283 | 600 |
| 11 | 1016 | 81·4 | 1388 | 586 |
| 12 | 1074 | 93·3 | 1492 | 574 |
| 13 | 1131 | 105·8 | 1593 | 563 |
| 14 | 1185 | 118·8 | 1693 | 552 |
| 15 | 1237 | 132·3 | 1792 | 543 |
| 16 | 1288 | 146·4 | 1889 | 535 |
| 17 | 1337 | 161·0 | 1986 | 527 |
| 18 | 1385 | 176·0 | 2082 | 520 |
| 19 | 1431 | 191·6 | 2177 | 514 |
| 20 | 1477 | 207·7 | 2272 | 508 |
| 21 | 1521 | 224·4 | 2366 | 502 |
| 22 | 1565 | 241·6 | 2459 | 497 |
| 23 | 1608 | 259·3 | 2553 | 493 |
| 24 | 1650 | 277·5 | 2646 | 489 |
| 25 | 1691 | 296·4 | 2740 | 485 |
| 26 | 1732 | 315·8 | 2833 | 481 |
| 27 | 1772 | 335·8 | 2926 | 478 |
| 28 | 1811 | 356·4 | 3020 | 475 |
| 29 | 1851 | 377·6 | 3114 | 472 |
| 30 | 1889 | 399·5 | 3209 | 470 |

$\gamma = 7{\cdot}2$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 31° | 1928 | 422·1 | 3304 | 468 |
| 32 | 1966 | 445·4 | 3399 | 466 |
| 33 | 2003 | 469·4 | 3495 | 464 |
| 34 | 2041 | 494·1 | 3592 | 462 |
| 35 | 2078 | 519·7 | 3690 | 461 |
| 36 | 2115 | 546·0 | 3788 | 460 |
| 37 | 2152 | 573·2 | 3888 | 459 |
| 38 | 2188 | 601·4 | 3989 | 458 |
| 39 | 2225 | 630·4 | 4091 | 457 |
| 40 | 2261 | 660·4 | 4194 | 457 |
| 41 | 2298 | 691·5 | 4299 | 456 |
| 42 | 2334 | 723·6 | 4405 | 456 |
| 43 | 2370 | 756·8 | 4513 | 456 |
| 44 | 2406 | 791·3 | 4623 | 456 |
| 45 | 2443 | 826·9 | 4735 | 456 |

$\gamma = 7{\cdot}4$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 2°·5 | 931 | 26·9 | 610 | 3217 |
| 2·0 | 530 | 10·7 | 426 | 1647 |
| 1·0 | 204 | 1·9 | 188 | 1178 |
| 0 | 0 | 0 | 0 | 1000 |

$\gamma = 7{\cdot}6$

| $\phi$ | (X) | (Y) | (T) | (V) |
|---|---|---|---|---|
| 2°·0 | 542 | 11·1 | 430 | 1701 |
| 1·0 | 205 | 1·9 | 189 | 1185 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 156 | 1·3 | 165 | 895 |
| 2 | 284 | 4·6 | 314 | 823 |
| 3 | 394 | 9·4 | 453 | 770 |
| 4 | 492 | 15·4 | 584 | 729 |
| 5 | 581 | 22·4 | 709 | 696 |
| 6 | 662 | 30·2 | 828 | 668 |
| 7 | 737 | 38·7 | 944 | 645 |
| 8 | 807 | 48·0 | 1056 | 625 |
| 9 | 873 | 57·9 | 1164 | 607 |
| 10 | 936 | 68·3 | 1270 | 591 |

XVI. (*continued*).

| $\gamma = 7{\cdot}6$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 11° | 996 | 79·4 | 1374 | 578 |
| 12 | 1053 | 91·0 | 1476 | 565 |
| 13 | 1107 | 103·1 | 1576 | 554 |
| 14 | 1160 | 115·7 | 1674 | 544 |
| 15 | 1211 | 128·8 | 1771 | 535 |
| 16 | 1260 | 142·4 | 1867 | 526 |
| 17 | 1307 | 156·6 | 1963 | 519 |
| 18 | 1354 | 171·2 | 2057 | 512 |
| 19 | 1399 | 186·3 | 2151 | 506 |
| 20 | 1443 | 201·9 | 2244 | 500 |
| 21 | 1486 | 218·0 | 2336 | 494 |
| 22 | 1528 | 234·6 | 2428 | 489 |
| 23 | 1570 | 251·7 | 2520 | 485 |
| 24 | 1610 | 269·4 | 2612 | 481 |
| 25 | 1650 | 287·6 | 2704 | 477 |
| 26 | 1690 | 306·4 | 2796 | 473 |
| 27 | 1728 | 325·7 | 2888 | 470 |
| 28 | 1767 | 345·7 | 2980 | 467 |
| 29 | 1805 | 366·2 | 3072 | 464 |
| 30 | 1842 | 387·4 | 3165 | 462 |
| 31 | 1879 | 409·2 | 3259 | 460 |
| 32 | 1916 | 431·7 | 3353 | 458 |
| 33 | 1952 | 454·9 | 3447 | 456 |
| 34 | 1988 | 478·9 | 3542 | 454 |
| 35 | 2024 | 503·5 | 3638 | 453 |
| 36 | 2060 | 529·0 | 3735 | 452 |
| 37 | 2096 | 555·3 | 3833 | 451 |
| 38 | 2131 | 582·5 | 3932 | 450 |
| 39 | 2166 | 610·5 | 4033 | 449 |
| 40 | 2201 | 639·5 | 4134 | 449 |
| 41 | 2236 | 669·5 | 4237 | 448 |
| 42 | 2272 | 700·6 | 4342 | 448 |
| 43 | 2307 | 732·7 | 4448 | 448 |
| 44 | 2342 | 765·9 | 4555 | 448 |
| 45 | 2377 | 800·4 | 4665 | 448 |

| $\gamma = 7{\cdot}8$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 2·0° | 555 | 11·4 | 435 | 1764 |
| 1·0 | 206 | 1·9 | 189 | 1192 |
| 0 | 0 | 0 | 0 | 1000 |

| $\gamma = 8{\cdot}0$ | | | | |
|---|---|---|---|---|
| $\phi$ | (x) | (y) | (T) | (v) |
| 2·0° | 569 | 11·8 | 439 | 1837 |
| 1·0 | 207 | 1·9 | 190 | 1199 |
| 0 | 0 | 0 | 0 | 1000 |
| 1 | 155 | 1·3 | 164 | 889 |
| 2 | 281 | 4·6 | 313 | 817 |
| 3 | 390 | 9·3 | 451 | 763 |
| 4 | 486 | 15·2 | 580 | 722 |
| 5 | 572 | 22·0 | 704 | 688 |
| 6 | 652 | 29·6 | 822 | 660 |
| 7 | 725 | 37·9 | 936 | 637 |
| 8 | 794 | 46·9 | 1046 | 617 |
| 9 | 858 | 56·6 | 1153 | 599 |
| 10 | 919 | 66·8 | 1258 | 583 |
| 11 | 977 | 77·5 | 1360 | 570 |
| 12 | 1032 | 88·8 | 1460 | 557 |
| 13 | 1085 | 100·5 | 1559 | 546 |
| 14 | 1136 | 112·8 | 1656 | 536 |
| 15 | 1186 | 125·5 | 1752 | 527 |
| 16 | 1233 | 138·7 | 1846 | 519 |
| 17 | 1280 | 152·4 | 1940 | 511 |
| 18 | 1325 | 166·6 | 2033 | 504 |
| 19 | 1368 | 181·3 | 2125 | 498 |
| 20 | 1411 | 196·4 | 2217 | 492 |
| 21 | 1453 | 212·0 | 2308 | 487 |
| 22 | 1494 | 228·1 | 2399 | 482 |
| 23 | 1534 | 244·8 | 2489 | 477 |
| 24 | 1573 | 261·9 | 2580 | 473 |
| 25 | 1612 | 279·5 | 2670 | 469 |
| 26 | 1650 | 297·7 | 2761 | 466 |
| 27 | 1688 | 316·5 | 2851 | 463 |
| 28 | 1725 | 335·8 | 2942 | 460 |
| 29 | 1762 | 355·7 | 3033 | 457 |
| 30 | 1798 | 376·2 | 3124 | 455 |
| 31 | 1834 | 397·3 | 3216 | 452 |
| 32 | 1869 | 419·1 | 3308 | 450 |
| 33 | 1905 | 441·6 | 3402 | 449 |
| 34 | 1940 | 464·7 | 3495 | 447 |
| 35 | 1974 | 488·6 | 3590 | 446 |
| 36 | 2009 | 513·3 | 3685 | 445 |
| 37 | 2043 | 538·8 | 3782 | 444 |
| 38 | 2077 | 565·0 | 3879 | 443 |
| 39 | 2112 | 592·2 | 3978 | 442 |
| 40 | 2146 | 620·3 | 4078 | 441 |
| 41 | 2180 | 649·3 | 4179 | 441 |
| 42 | 2214 | 679·3 | 4282 | 441 |
| 43 | 2247 | 710·4 | 4386 | 441 |
| 44 | 2281 | 742·5 | 4492 | 441 |
| 45 | 2315 | 775·9 | 4600 | 441 |

## XVII.

### Values of $\{1000 \div v\}^3$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 40 | 15·63 | 15·51 | 15·39 | 15·28 | 15·17 | 15·05 | 14·94 | 14·83 | 14·72 | 14·62 | 11 |
| 41 | 14·51 | 14·40 | 14·30 | 14·20 | 14·09 | 13·99 | 13·89 | 13·79 | 13·69 | 13·59 | 10 |
| 42 | 13·50 | 13·40 | 13·31 | 13·21 | 13·12 | 13·03 | 12·94 | 12·85 | 12·76 | 12·67 | 9 |
| 43 | 12·578 | 2·491 | 2·404 | 2·318 | 2·233 | 2·149 | 2·065 | 1·983 | 1·901 | 1·820 | 84 |
| 44 | 1·739 | 1·660 | 1·581 | 1·503 | 1·425 | 1·348 | 1·272 | 1·197 | 1·122 | 1·048 | 77 |
| 45 | 0·974 | 0·901 | 0·829 | 0·757 | 0·686 | 0·616 | 0·547 | 0·478 | 0·409 | 0·341 | 70 |
| 46 | 10·274 | 0·207 | 0·141 | 0·075 | 0·010 | *9·946 | *9·882 | *9·819 | *9·756 | *9·694 | 64 |
| 47 | 09·632 | 9·571 | 9·510 | 9·450 | 9·390 | 9·331 | 9·272 | 9·214 | 9·156 | 9·099 | 59 |
| 48 | 9·042 | 8·986 | 8·930 | 8·875 | 8·820 | 8·766 | 8·711 | 8·658 | 8·605 | 8·552 | 54 |
| 49 | 8·500 | 8·448 | 8·397 | 8·346 | 8·295 | 8·245 | 8·195 | 8·146 | 8·097 | 8·048 | 50 |
| 50 | 8·000 | 7·952 | 7·905 | 7·858 | 7·811 | 7·765 | 7·719 | 7·673 | 7·628 | 7·583 | 46 |
| 51 | 7·539 | 7·494 | 7·451 | 7·407 | 7·364 | 7·321 | 7·279 | 7·237 | 7·195 | 7·153 | 43 |
| 52 | 7·112 | 7·071 | 7·031 | 6·990 | 6·950 | 6·911 | 6·871 | 6·832 | 6·794 | 6·755 | 40 |
| 53 | 6·717 | 6·679 | 6·642 | 6·604 | 6·567 | 6·530 | 6·494 | 6·458 | 6·422 | 6·386 | 37 |
| 54 | 6·351 | 6·316 | 6·281 | 6·246 | 6·212 | 6·178 | 6·144 | 6·110 | 6·077 | 6·043 | 34 |
| 55 | 6·011 | 5·978 | 5·945 | 5·913 | 5·881 | 5·850 | 5·818 | 5·787 | 5·756 | 5·725 | 32 |
| 56 | 5·694 | 5·664 | 5·634 | 5·604 | 5·574 | 5·544 | 5·515 | 5·486 | 5·457 | 5·428 | 30 |
| 57 | 5·400 | 5·372 | 5·343 | 5·315 | 5·288 | 5·260 | 5·233 | 5·206 | 5·179 | 5·152 | 28 |
| 58 | 5·125 | 5·099 | 5·073 | 5·047 | 5·021 | 4·995 | 4·969 | 4·944 | 4·919 | 4·894 | 26 |
| 59 | 4·869 | 4·844 | 4·820 | 4·796 | 4·771 | 4·747 | 4·724 | 4·700 | 4·676 | 4·653 | 24 |
| 60 | 4·630 | 4·607 | 4·584 | 4·561 | 4·538 | 4·516 | 4·494 | 4·471 | 4·449 | 4·427 | 23 |
| 61 | 4·406 | 4·384 | 4·363 | 4·341 | 4·320 | 4·299 | 4·278 | 4·257 | 4·237 | 4·216 | 21 |
| 62 | 4·196 | 4·176 | 4·156 | 4·136 | 4·116 | 4·096 | 4·076 | 4·057 | 4·038 | 4·018 | 20 |
| 63 | 3·999 | 3·980 | 3·961 | 3·943 | 3·924 | 3·906 | 3·887 | 3·869 | 3·851 | 3·833 | 19 |
| 64 | 3·815 | 3·797 | 3·779 | 3·762 | 3·744 | 3·727 | 3·709 | 3·692 | 3·675 | 3·658 | 17 |
| 65 | 3·641 | 3·625 | 3·608 | 3·591 | 3·575 | 3·559 | 3·542 | 3·526 | 3·510 | 3·494 | 16 |
| 66 | 3·478 | 3·463 | 3·447 | 3·431 | 3·416 | 3·400 | 3·385 | 3·370 | 3·355 | 3·340 | 15 |
| 67 | 3·325 | 3·310 | 3·295 | 3·281 | 3·266 | 3·252 | 3·237 | 3·223 | 3·209 | 3·194 | 15 |
| 68 | 3·180 | 3·166 | 3·152 | 3·139 | 3·125 | 3·111 | 3·098 | 3·084 | 3·071 | 3·057 | 14 |
| 69 | 3·044 | 3·031 | 3·018 | 3·005 | 2·992 | 2·979 | 2·966 | 2·953 | 2·941 | 2·928 | 13 |
| 70 | 2·915 | 2·903 | 2·891 | 2·878 | 2·866 | 2·854 | 2·842 | 2·830 | 2·818 | 2·806 | 12 |
| 71 | 2·794 | 2·782 | 2·770 | 2·759 | 2·747 | 2·736 | 2·724 | 2·713 | 2·702 | 2·690 | 12 |
| 72 | 2·679 | 2·668 | 2·657 | 2·646 | 2·635 | 2·624 | 2·613 | 2·603 | 2·592 | 2·581 | 11 |
| 73 | 2·571 | 2·560 | 2·550 | 2·539 | 2·529 | 2·518 | 2·508 | 2·498 | 2·488 | 2·478 | 10 |
| 74 | 2·468 | 2·458 | 2·448 | 2·438 | 2·428 | 2·418 | 2·409 | 2·399 | 2·389 | 2·379 | 10 |
| 75 | 2·370 | 2·361 | 2·352 | 2·342 | 2·333 | 2·324 | 2·314 | 2·305 | 2·296 | 2·287 | 9 |

## XVII. (*continued*).

$\{1000 \div v\}^3$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 76 | 2·2780 | 2691 | 2601 | 2513 | 2424 | 2337 | 2249 | 2162 | 2076 | 1990 | 88 |
| 77 | 1904 | 1819 | 1734 | 1650 | 1566 | 1483 | 1400 | 1318 | 1235 | 1154 | 83 |
| 78 | 1073 | 0992 | 0911 | 0831 | 0752 | 0672 | 0594 | 0515 | 0437 | 0360 | 79 |
| 79 | 0282 | 0206 | 0129 | 0053 | *9977 | *9902 | *9827 | *9753 | *9679 | *9605 | 75 |
| 80 | 1·9531 | 9458 | 9386 | 9313 | 9241 | 9170 | 9098 | 9027 | 8957 | 8887 | 72 |
| 81 | 1·8817 | 8747 | 8678 | 8609 | 8541 | 8473 | 8405 | 8337 | 8270 | 8203 | 68 |
| 82 | 8137 | 8071 | 8005 | 7939 | 7874 | 7809 | 7744 | 7680 | 7616 | 7552 | 65 |
| 83 | 7489 | 7426 | 7363 | 7301 | 7239 | 7177 | 7115 | 7054 | 6993 | 6932 | 62 |
| 84 | 6872 | 6812 | 6752 | 6692 | 6633 | 6574 | 6515 | 6457 | 6399 | 6341 | 59 |
| 85 | 6283 | 6226 | 6169 | 6112 | 6056 | 5999 | 5943 | 5888 | 5832 | 5777 | 56 |
| 86 | 1·5722 | 5667 | 5613 | 5559 | 5505 | 5451 | 5397 | 5344 | 5291 | 5239 | 54 |
| 87 | 5186 | 5134 | 5082 | 5030 | 4978 | 4927 | 4876 | 4825 | 4775 | 4724 | 51 |
| 88 | 4674 | 4624 | 4575 | 4525 | 4476 | 4427 | 4378 | 4329 | 4281 | 4233 | 49 |
| 89 | 4185 | 4137 | 4090 | 4043 | 3996 | 3949 | 3902 | 3856 | 3809 | 3763 | 47 |
| 90 | 3717 | 3672 | 3626 | 3581 | 3536 | 3491 | 3447 | 3402 | 3358 | 3314 | 45 |
| 91 | 1·3270 | 3227 | 3183 | 3140 | 3097 | 3054 | 3011 | 2969 | 2926 | 2884 | 43 |
| 92 | 2842 | 2800 | 2759 | 2717 | 2676 | 2635 | 2594 | 2553 | 2513 | 2473 | 41 |
| 93 | 2432 | 2392 | 2352 | 2313 | 2273 | 2234 | 2195 | 2156 | 2117 | 2078 | 39 |
| 94 | 2040 | 2001 | 1963 | 1925 | 1887 | 1850 | 1812 | 1775 | 1738 | 1700 | 38 |
| 95 | 1664 | 1627 | 1590 | 1554 | 1517 | 1481 | 1445 | 1410 | 1374 | 1338 | 36 |
| 96 | 1·1303 | 1268 | 1233 | 1198 | 1163 | 1128 | 1094 | 1059 | 1025 | 0991 | 35 |
| 97 | 0957 | 0923 | 0889 | 0856 | 0822 | 0789 | 0756 | 0723 | 0690 | 0657 | 33 |
| 98 | 0625 | 0592 | 0560 | 0528 | 0496 | 0464 | 0432 | 0400 | 0369 | 0337 | 32 |
| 99 | 0306 | 0275 | 0244 | 0213 | 0182 | 0152 | 0121 | 0091 | 0060 | 0030 | 31 |
| 100 | 0000 | *9970 | *9940 | *9911 | *9881 | *9852 | *9822 | *9793 | *9764 | *9735 | 30 |
| 101 | 0·9706 | 9677 | 9649 | 9620 | 9592 | 9563 | 9535 | 9507 | 9479 | 9451 | 28 |
| 102 | 9423 | 9396 | 9368 | 9341 | 9313 | 9286 | 9259 | 9232 | 9205 | 9178 | 27 |
| 103 | 9151 | 9125 | 9098 | 9072 | 9046 | 9019 | 8993 | 8967 | 8941 | 8916 | 26 |
| 104 | 8890 | 8864 | 8839 | 8814 | 8788 | 8763 | 8738 | 8713 | 8688 | 8663 | 25 |
| 105 | 8638 | 8614 | 8589 | 8565 | 8540 | 8516 | 8492 | 8468 | 8444 | 8420 | 24 |
| 106 | 0·8396 | 8373 | 8349 | 8325 | 8302 | 8279 | 8255 | 8232 | 8209 | 8186 | 23 |
| 107 | 8163 | 8140 | 8117 | 8095 | 8072 | 8050 | 8027 | 8005 | 7983 | 7960 | 23 |
| 108 | 7938 | 7916 | 7894 | 7873 | 7851 | 7829 | 7808 | 7786 | 7765 | 7743 | 22 |
| 109 | 7722 | 7701 | 7680 | 7658 | 7637 | 7617 | 7596 | 7575 | 7554 | 7534 | 21 |
| 110 | 7513 | 7493 | 7472 | 7452 | 7432 | 7412 | 7392 | 7372 | 7352 | 7332 | 20 |
| 111 | 0·7312 | 7292 | 7273 | 7253 | 7233 | 7214 | 7195 | 7175 | 7156 | 7137 | 19 |
| 112 | 7118 | 7099 | 7080 | 7061 | 7042 | 7023 | 7005 | 6986 | 6967 | 6949 | 19 |
| 113 | 6931 | 6912 | 6894 | 6876 | 6857 | 6839 | 6821 | 6803 | 6785 | 6768 | 18 |
| 114 | 6750 | 6732 | 6714 | 6697 | 6679 | 6662 | 6644 | 6627 | 6610 | 6592 | 17 |
| 115 | 6575 | 6558 | 6541 | 6524 | 6507 | 6490 | 6473 | 6457 | 6440 | 6423 | 17 |

## XVII. (*continued*).

$\{1000 \div v\}^3$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | — |
| 116 | 0·6407 | 6390 | 6374 | 6357 | 6341 | 6324 | 6308 | 6292 | 6276 | 6260 | 16 |
| 117 | 6244 | 6228 | 6212 | 6196 | 6180 | 6164 | 6149 | 6133 | 6117 | 6102 | 16 |
| 118 | 6086 | 6071 | 6056 | 6040 | 6025 | 6010 | 5994 | 5979 | 5964 | 5949 | 15 |
| 119 | 5934 | 5919 | 5904 | 5890 | 5875 | 5860 | 5845 | 5831 | 5816 | 5802 | 15 |
| 120 | 5787 | 5773 | 5758 | 5744 | 5730 | 5715 | 5701 | 5687 | 5673 | 5659 | 14 |
| 121 | 0·5645 | 5631 | 5617 | 5603 | 5589 | 5575 | 5562 | 5548 | 5534 | 5521 | 14 |
| 122 | 5507 | 5494 | 5480 | 5467 | 5453 | 5440 | 5427 | 5413 | 5400 | 5387 | 13 |
| 123 | 5374 | 5361 | 5348 | 5335 | 5322 | 5309 | 5296 | 5283 | 5270 | 5258 | 13 |
| 124 | 5245 | 5232 | 5220 | 5207 | 5194 | 5182 | 5170 | 5157 | 5145 | 5132 | 13 |
| 125 | 5120 | 5108 | 5096 | 5083 | 5071 | 5059 | 5047 | 5035 | 5023 | 5011 | 12 |
| 126 | 0·4999 | 4987 | 4975 | 4964 | 4952 | 4940 | 4928 | 4917 | 4905 | 4893 | 12 |
| 127 | 4882 | 4870 | 4859 | 4848 | 4836 | 4825 | 4813 | 4802 | 4791 | 4780 | 11 |
| 128 | 4768 | 4757 | 4746 | 4735 | 4724 | 4713 | 4702 | 4691 | 4680 | 4669 | 11 |
| 129 | 4658 | 4648 | 4637 | 4626 | 4615 | 4605 | 4594 | 4583 | 4573 | 4562 | 11 |
| 130 | 4552 | 4541 | 4531 | 4520 | 4510 | 4500 | 4489 | 4479 | 4469 | 4458 | 10 |
| 131 | 0·4448 | 4438 | 4428 | 4418 | 4408 | 4398 | 4388 | 4378 | 4368 | 4358 | 10 |
| 132 | 4348 | 4338 | 4328 | 4318 | 4309 | 4299 | 4289 | 4279 | 4270 | 4260 | 10 |
| 133 | 4251 | 4241 | 4231 | 4222 | 4212 | 4203 | 4194 | 4184 | 4175 | 4165 | 9 |
| 134 | 4156 | 4147 | 4138 | 4128 | 4119 | 4110 | 4101 | 4092 | 4083 | 4074 | 9 |
| 135 | 4064 | 4055 | 4046 | 4037 | 4029 | 4020 | 4011 | 4002 | 3993 | 3984 | 9 |
| 136 | 0·3975 | 3967 | 3958 | 3949 | 3941 | 3932 | 3923 | 3915 | 3906 | 3898 | 9 |
| 137 | 3889 | 3881 | 3872 | 3864 | 3855 | 3847 | 3838 | 3830 | 3822 | 3813 | 8 |
| 138 | 3805 | 3797 | 3789 | 3780 | 3772 | 3764 | 3756 | 3748 | 3740 | 3732 | 8 |
| 139 | 3724 | 3716 | 3708 | 3700 | 3692 | 3684 | 3676 | 3668 | 3660 | 3652 | 8 |
| 140 | 3644 | 3637 | 3629 | 3621 | 3613 | 3606 | 3598 | 3590 | 3583 | 3575 | 8 |
| 141 | 0·3567 | 3560 | 3552 | 3545 | 3537 | 3530 | 3522 | 3515 | 3507 | 3500 | 8 |
| 142 | 3493 | 3485 | 3478 | 3470 | 3463 | 3456 | 3449 | 3441 | 3434 | 3427 | 7 |
| 143 | 3420 | 3413 | 3405 | 3398 | 3391 | 3384 | 3377 | 3370 | 3363 | 3356 | 7 |
| 144 | 3349 | 3342 | 3335 | 3328 | 3321 | 3314 | 3308 | 3301 | 3294 | 3287 | 7 |
| 145 | 3280 | 3273 | 3267 | 3260 | 3253 | 3247 | 3240 | 3233 | 3227 | 3220 | 7 |
| 146 | 0·3 2132 | 2066 | 2001 | 1935 | 1870 | 1804 | 1739 | 1674 | 1610 | 1545 | 65 |
| 147 | 1481 | 1417 | 1353 | 1289 | 1225 | 1162 | 1099 | 1036 | 0973 | 0910 | 63 |
| 148 | 0847 | 0785 | 0722 | 0660 | 0598 | 0537 | 0475 | 0414 | 0352 | 0291 | 62 |
| 149 | 0230 | 0169 | 0109 | 0048 | *9988 | *9928 | *9868 | *9808 | *9748 | *9689 | 60 |
| 150 | 0·2 9630 | 9570 | 9511 | 9452 | 9394 | 9335 | 9277 | 9219 | 9161 | 9103 | 59 |
| 151 | 0·2 9045 | 8987 | 8930 | 8872 | 8815 | 8758 | 8701 | 8645 | 8588 | 8532 | 57 |
| 152 | 8475 | 8419 | 8363 | 8307 | 8252 | 8196 | 8141 | 8086 | 8030 | 7975 | 56 |
| 153 | 7921 | 7866 | 7811 | 7757 | 7703 | 7649 | 7595 | 7541 | 7487 | 7434 | 54 |
| 154 | 7380 | 7327 | 7274 | 7221 | 7168 | 7115 | 7063 | 7010 | 6958 | 6906 | 53 |
| 155 | 6854 | 6802 | 6750 | 6698 | 6647 | 6596 | 6544 | 6493 | 6442 | 6391 | 51 |

## XVIII.

$$W_\phi = \tan\phi\left(\sec^5\phi + \frac{5}{4}\sec^3\phi + \frac{15}{8}\sec\phi\right) + \frac{15}{8}\log_e\tan\left(\frac{\pi}{4}+\frac{\phi}{2}\right).$$

| $\phi$ | $W_\phi$ | Log $W_\phi$ | Log $\Delta W_\phi$ | $\phi$ | $W_\phi$ | Log $W_\phi$ | Log $\Delta W_\phi$ |
|---|---|---|---|---|---|---|---|
| 1° | 0·10476 | 9·02020 | 9·02020 | 41° | 9·7112 | 0·98727 | |
| 2 | 0·20974 | 9·32168 | 9·02111 | 42 | 10·504 | 1·02135 | 9·89910 |
| 3 | 0·31517 | 9·49855 | 9·02296 | 43 | 11·389 | 1·05648 | 9·94691 |
| 4 | 0·42127 | 9·62456 | 9·02572 | 44 | 12·381 | 1·09274 | 9·99641 |
| 5 | 0·52829 | 9·72287 | 9·02947 | 45 | 13·497 | 1·13023 | 0·04767 |
| 6 | 0·63646 | 9·80377 | 9·03411 | 46 | 14·758 | 1·16902 | 0·10075 |
| 7 | 0·74603 | 9·87276 | 9·03969 | 47 | 16·189 | 1·20922 | 0·15573 |
| 8 | 0·85725 | 9·93311 | 9·04618 | 48 | 17·821 | 1·25093 | 0·21265 |
| 9 | 0·97040 | 9·98695 | 9·05366 | 49 | 19·690 | 1·29424 | 0·27160 |
| 10 | 1·0858 | 0·03573 | 9·06206 | 50 | 21·841 | 1·33927 | 0·33268 |
| 11 | 1·2036 | 0·08049 | 9·07140 | 51 | 24·330 | 1·38612 | 0·39595 |
| 12 | 1·3243 | 0·12200 | 9·08174 | 52 | 27·224 | 1·43495 | 0·46151 |
| 13 | 1·4482 | 0·16083 | 9·09300 | 53 | 30·608 | 1·48583 | 0·52946 |
| 14 | 1·5757 | 0·19746 | 9·10527 | 54 | 34·588 | 1·53893 | 0·59992 |
| 15 | 1·7070 | 0·23224 | 9·11850 | 55 | 39·298 | 1·59437 | 0·67300 |
| 16 | 1·8428 | 0·26547 | 9·13271 | 56 | 44·906 | 1·65230 | 0·74882 |
| 17 | 1·9834 | 0·29740 | 9·14795 | 57 | 51·629 | 1·71289 | 0·82755 |
| 18 | 2·1293 | 0·32823 | 9·16415 | 58 | 59·744 | 1·77630 | 0·90931 |
| 19 | 2·2811 | 0·35815 | 9·18142 | 59 | 69·614 | 1·84270 | 0·99430 |
| 20 | 2·4395 | 0·38730 | 9·19967 | 60 | 81·711 | 1·91228 | 1·08268 |
| 21 | 2·6051 | 0·41582 | 9·21901 | 61 | 96·661 | 1·98525 | 1·17464 |
| 22 | 2·7786 | 0·44383 | 9·23938 | 62 | 115·30 | 2·06184 | 1·27049 |
| 23 | 2·9609 | 0·47143 | 9·26081 | 63 | 138·76 | 2·14228 | 1·37035 |
| 24 | 3·1529 | 0·49871 | 9·28332 | 64 | 168·59 | 2·22684 | 1·47462 |
| 25 | 3·3557 | 0·52578 | 9·30698 | 65 | 206·92 | 2·31580 | 1·58353 |
| 26 | 3·5703 | 0·55271 | 9·33171 | 66 | 256·75 | 2·40951 | 1·69747 |
| 27 | 3·7982 | 0·57957 | 9·35761 | 67 | 322·33 | 2·50831 | 1·81681 |
| 28 | 4·0406 | 0·60645 | 9·38466 | 68 | 409·83 | 2·61260 | 1·94199 |
| 29 | 4·2994 | 0·63341 | 9·41286 | 69 | 528·28 | 2·72286 | 2·07352 |
| 30 | 4·5763 | 0·66051 | 9·44229 | 70 | 691·22 | 2·83962 | 2·21204 |
| 31 | 4·8734 | 0·68783 | 9·47293 | 71 | 919·27 | 2·96344 | 2·35804 |
| 32 | 5·1931 | 0·71543 | 9·50481 | 72 | 1244·7 | 3·09508 | 2·51250 |
| 33 | 5·5383 | 0·74337 | 9·53800 | 73 | 1719·2 | 3·23532 | 2·67617 |
| 34 | 5·9119 | 0·77173 | 9·57245 | 74 | 2427·4 | 3·38514 | 2·85019 |
| 35 | 6·3177 | 0·80056 | 9·60826 | 75 | 3513·3 | 3·54572 | 3·03579 |
| 36 | 6·7597 | 0·82992 | 9·64542 | 76 | 5229·2 | 3·71843 | 3·23448 |
| 37 | 7·2427 | 0·85990 | 9·68399 | 77 | 8035·4 | 3·90501 | 3·44813 |
| 38 | 7·7723 | 0·89055 | 9·72399 | 78 | 12811 | 4·10757 | 3·67899 |
| 39 | 8·3550 | 0·92195 | 9·76545 | 79 | 21321 | 4·32880 | 3·92994 |
| 40 | 8·9984 | 0·95416 | 9·80843 | 80 | 37339 | 4·57217 | 4·20462 |
| | | | 9·85297 | | | | |

## XIX.

$\{1000 \div v\}^6$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 50 | 64·00 | 63·24 | 62·49 | 61·74 | 61·01 | 60·30 | 59·58 | 58·88 | 58·19 | 57·50 | 72 |
| 51 | 56·83 | 56·17 | 55·51 | 54·87 | 54·23 | 53·60 | 52·98 | 52·37 | 51·76 | 51·17 | 63 |
| 52 | 50·57 | 50·00 | 49·42 | 48·86 | 48·31 | 47·76 | 47·22 | 46·68 | 46·15 | 45·63 | 55 |
| 53 | 45·12 | 44·61 | 44·11 | 43·62 | 43·13 | 42·65 | 42·17 | 41·70 | 41·24 | 40·78 | 48 |
| 54 | 40·33 | 39·89 | 39·45 | 39·01 | 38·58 | 38·16 | 37·74 | 37·33 | 36·93 | 36·52 | 42 |
| 55 | 36·13 | 35·74 | 35·35 | 34·97 | 34·59 | 34·22 | 33·85 | 33·49 | 33·13 | 32·77 | 37 |
| 56 | 32·42 | 32·08 | 31·74 | 31·40 | 31·07 | 30·74 | 30·42 | 30·10 | 29·78 | 29·47 | 33 |
| 57 | 29·16 | 28·85 | 28·55 | 28·25 | 27·96 | 27·67 | 27·38 | 27·10 | 26·82 | 26·54 | 29 |
| 58 | 26·27 | 26·00 | 25·73 | 25·47 | 25·21 | 24·95 | 24·70 | 24·44 | 24·20 | 23·95 | 26 |
| 59 | 23·71 | 23·47 | 23·23 | 23·00 | 22·77 | 22·54 | 22·31 | 22·09 | 21·87 | 21·65 | 23 |
| 60 | 21·43 | 21·22 | 21·01 | 20·80 | 20·60 | 20·39 | 20·19 | 19·99 | 19·80 | 19·60 | 20 |
| 61 | 19·41 | 19·22 | 19·03 | 18·85 | 18·66 | 18·48 | 18·30 | 18·13 | 17·95 | 17·78 | 18 |
| 62 | 17·61 | 17·44 | 17·27 | 17·10 | 16·94 | 16·78 | 16·62 | 16·46 | 16·30 | 16·15 | 16 |
| 63 | 16·00 | 15·84 | 15·69 | 15·54 | 15·40 | 15·25 | 15·11 | 14·97 | 14·83 | 14·69 | 15 |
| 64 | 14·55 | 14·42 | 14·28 | 14·15 | 14·02 | 13·89 | 13·76 | 13·63 | 13·51 | 13·38 | 13 |
| 65 | 13·26 | 13·14 | 13·02 | 12·90 | 12·78 | 12·66 | 12·55 | 12·43 | 12·32 | 12·21 | 12 |
| 66 | 12·10 | 11·99 | 11·88 | 11·77 | 11·67 | 11·56 | 11·46 | 11·36 | 11·25 | 11·15 | 11 |
| 67 | 11·05 | 10·96 | 10·86 | 10·76 | 10·67 | 10·57 | 10·48 | 10·39 | 10·30 | 10·20 | 9 |
| 68 | 10·114 | 10·025 | 9·938 | 9·851 | 9·765 | 9·679 | 9·595 | 9·512 | 9·429 | 9·347 | 85 |
| 69 | 9·266 | 9·186 | 9·106 | 9·027 | 8·950 | 8·874 | 8·797 | 8·722 | 8·646 | 8·572 | 77 |
| 70 | 8·500 | 8·427 | 8·355 | 8·284 | 8·214 | 8·144 | 8·076 | 8·007 | 7·940 | 7·873 | 70 |
| 71 | 7·806 | 7·741 | 7·676 | 7·611 | 7·548 | 7·485 | 7·422 | 7·360 | 7·299 | 7·238 | 63 |
| 72 | 7·178 | 7·119 | 7·060 | 7·001 | 6·943 | 6·886 | 6·829 | 6·773 | 6·718 | 6·662 | 57 |
| 73 | 6·608 | 6·554 | 6·500 | 6·447 | 6·395 | 6·343 | 6·291 | 6·240 | 6·190 | 6·140 | 52 |
| 74 | 6·090 | 6·041 | 5·992 | 5·944 | 5·896 | 5·849 | 5·802 | 5·755 | 5·709 | 5·664 | 47 |
| 75 | 5·619 | 5·574 | 5·530 | 5·486 | 5·442 | 5·399 | 5·356 | 5·314 | 5·272 | 5·230 | 43 |
| 76 | 5·189 | 5·149 | 5·108 | 5·068 | 5·028 | 4·989 | 4·950 | 4·912 | 4·873 | 4·836 | 39 |
| 77 | 4·798 | 4·761 | 4·724 | 4·687 | 4·651 | 4·615 | 4·580 | 4·544 | 4·509 | 4·475 | 36 |
| 78 | 4·440 | 4·407 | 4·373 | 4·339 | 4·306 | 4·273 | 4·241 | 4·209 | 4·177 | 4·145 | 33 |
| 79 | 4·114 | 4·083 | 4·052 | 4·021 | 3·991 | 3·961 | 3·931 | 3·902 | 3·872 | 3·843 | 30 |
| 80 | 3·815 | 3·786 | 3·758 | 3·730 | 3·702 | 3·675 | 3·647 | 3·620 | 3·594 | 3·567 | 28 |
| 81 | 3·541 | 3·515 | 3·489 | 3·463 | 3·438 | 3·412 | 3·387 | 3·362 | 3·338 | 3·314 | 25 |
| 82 | 3·289 | 3·265 | 3·242 | 3·218 | 3·195 | 3·172 | 3·149 | 3·126 | 3·103 | 3·081 | 23 |
| 83 | 3·059 | 3·037 | 3·015 | 2·993 | 2·972 | 2·950 | 2·929 | 2·908 | 2·888 | 2·867 | 21 |
| 84 | 2·847 | 2·826 | 2·806 | 2·786 | 2·767 | 2·747 | 2·728 | 2·708 | 2·689 | 2·670 | 20 |
| 85 | 2·651 | 2·633 | 2·614 | 2·596 | 2·578 | 2·560 | 2·542 | 2·524 | 2·507 | 2·489 | 18 |

## XIX. (*continued*).

$\{1000 \div v\}^6$.

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Δ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | | | | | | | | | | | – |
| 86 | 2·472 | 2·455 | 2·438 | 2·421 | 2·404 | 2·387 | 2·371 | 2·354 | 2·338 | 2·322 | 17 |
| 87 | 2·306 | 2·290 | 2·275 | 2·259 | 2·244 | 2·228 | 2·213 | 2·198 | 2·183 | 2·168 | 15 |
| 88 | 2·153 | 2·139 | 2·124 | 2·110 | 2·095 | 2·081 | 2·067 | 2·053 | 2·039 | 2·026 | 14 |
| 89 | 2·012 | 1·999 | 1·985 | 1·972 | 1·959 | 1·946 | 1·933 | 1·920 | 1·907 | 1·894 | 13 |
| 90 | 1·882 | 1·869 | 1·857 | 1·844 | 1·832 | 1·820 | 1·808 | 1·796 | 1·784 | 1·773 | 12 |
| 91 | 1·761 | 1·749 | 1·738 | 1·727 | 1·715 | 1·704 | 1·693 | 1·682 | 1·671 | 1·660 | 11 |
| 92 | 1·649 | 1·638 | 1·628 | 1·617 | 1·607 | 1·596 | 1·586 | 1·576 | 1·566 | 1·556 | 10 |
| 93 | 1·546 | 1·536 | 1·526 | 1·516 | 1·506 | 1·497 | 1·487 | 1·478 | 1·468 | 1·459 | 10 |
| 94 | 1·450 | 1·440 | 1·431 | 1·422 | 1·413 | 1·404 | 1·395 | 1·386 | 1·378 | 1·369 | 9 |
| 95 | 1·3604 | 3518 | 3433 | 3349 | 3265 | 3182 | 3099 | 3017 | 2936 | 2855 | 83 |
| 96 | 2775 | 2696 | 2617 | 2539 | 2461 | 2384 | 2307 | 2231 | 2155 | 2080 | 77 |
| 97 | 2005 | 1931 | 1858 | 1785 | 1713 | 1641 | 1569 | 1498 | 1428 | 1358 | 72 |
| 98 | 1·1289 | 1220 | 1151 | 1084 | 1016 | 0949 | 0883 | 0817 | 0751 | 0686 | 67 |
| 99 | 0622 | 0557 | 0494 | 0431 | 0368 | 0305 | 0243 | 0182 | 0121 | 0060 | 62 |
| 100 | 0000 | *9940 | *9881 | *9822 | *9764 | *9705 | *9647 | *9590 | *9533 | *9477 | 58 |
| 101 | 0·9420 | 9365 | 9309 | 9254 | 9200 | 9146 | 9092 | 9038 | 8985 | 8932 | 54 |
| 102 | 8880 | 8828 | 8776 | 8725 | 8674 | 8623 | 8573 | 8523 | 8473 | 8424 | 51 |
| 103 | 8375 | 8326 | 8278 | 8230 | 8182 | 8135 | 8088 | 8041 | 7995 | 7949 | 47 |
| 104 | 0·7903 | 7858 | 7813 | 7768 | 7723 | 7679 | 7635 | 7591 | 7548 | 7505 | 44 |
| 105 | 7462 | 7420 | 7378 | 7336 | 7294 | 7252 | 7211 | 7171 | 7130 | 7090 | 41 |
| 106 | 7050 | 7010 | 6970 | 6931 | 6892 | 6853 | 6815 | 6777 | 6739 | 6701 | 39 |
| 107 | 0·6663 | 6626 | 6589 | 6552 | 6516 | 6480 | 6444 | 6408 | 6372 | 6337 | 36 |
| 108 | 6302 | 6267 | 6232 | 6198 | 6163 | 6129 | 6096 | 6062 | 6029 | 5996 | 34 |
| 109 | 5963 | 5930 | 5897 | 5865 | 5833 | 5801 | 5769 | 5738 | 5707 | 5676 | 32 |
| 110 | 0·5645 | 5614 | 5584 | 5553 | 5523 | 5493 | 5463 | 5434 | 5405 | 5375 | 30 |
| 111 | 5346 | 5318 | 5289 | 5261 | 5232 | 5204 | 5176 | 5149 | 5121 | 5094 | 28 |
| 112 | 5066 | 5039 | 5012 | 4986 | 4959 | 4933 | 4906 | 4880 | 4854 | 4829 | 26 |
| 113 | 0·4803 | 4778 | 4752 | 4727 | 4702 | 4678 | 4653 | 4628 | 4604 | 4580 | 25 |
| 114 | 4556 | 4532 | 4508 | 4485 | 4461 | 4438 | 4415 | 4392 | 4369 | 4346 | 23 |
| 115 | 4323 | 4301 | 4278 | 4256 | 4234 | 4212 | 4190 | 4169 | 4147 | 4126 | 22 |
| 116 | 0·4104 | 4083 | 4062 | 4041 | 4021 | 4000 | 3979 | 3959 | 3939 | 3918 | 21 |
| 117 | 3898 | 3878 | 3859 | 3839 | 3819 | 3800 | 3781 | 3761 | 3742 | 3723 | 19 |
| 118 | 3704 | 3686 | 3667 | 3648 | 3630 | 3612 | 3593 | 3575 | 3557 | 3539 | 18 |
| 119 | 3521 | 3504 | 3486 | 3469 | 3451 | 3434 | 3417 | 3400 | 3383 | 3366 | 17 |

## XX.

Log $\tau$ corresponding to temperatures and pressures when the air is $\frac{2}{3}$rds saturated with moisture.

| Temperature | 15 in. | 20 in. | 22 in. | 24 in. | 26 in. | 27 in. | 28 in. | 29 in. | 30 in. | 31 in. |
|---|---|---|---|---|---|---|---|---|---|---|
| F | | | | | | | | | | |
| 9° | 9·7453 | 8703 | 9117 | 9494 | 9842 | *0006 | *0164 | *0317 | *0464 | *0606 |
| 10 | 7444 | 8693 | 9107 | 9485 | 9832 | 9996 | *0154 | *0306 | *0454 | *0596 |
| 11 | 7434 | 8684 | 9098 | 9476 | 9823 | 9987 | *0145 | *0297 | *0445 | *0587 |
| 12 | 9·7425 | 8674 | 9088 | 9466 | 9813 | 9977 | *0135 | *0288 | *0435 | *0577 |
| 13 | 7415 | 8665 | 9079 | 9457 | 9804 | 9968 | *0126 | *0278 | *0426 | *0568 |
| 14 | 7406 | 8656 | 9070 | 9447 | 9796 | 9959 | *0117 | *0269 | *0417 | *0559 |
| 15 | 9·7397 | 8646 | 9061 | 9438 | 9786 | 9950 | *0108 | *0260 | *0408 | *0550 |
| 16 | 7388 | 8637 | 9051 | 9429 | 9777 | 9941 | *0099 | *0251 | *0398 | *0541 |
| 17 | 7379 | 8628 | 9042 | 9420 | 9768 | 9931 | *0089 | *0242 | *0389 | *0532 |
| 18 | 9·7370 | 8619 | 9033 | 9411 | 9759 | 9922 | *0080 | *0233 | *0380 | *0522 |
| 19 | 7360 | 8609 | 9023 | 9401 | 9749 | 9913 | *0071 | *0223 | *0371 | *0513 |
| 20 | 7351 | 8600 | 9014 | 9392 | 9740 | 9903 | *0062 | *0215 | *0361 | *0503 |
| 21 | 9·7342 | 8591 | 9005 | 9383 | 9730 | 9895 | *0052 | *0205 | *0352 | *0495 |
| 22 | 7332 | 8582 | 8996 | 9374 | 9721 | 9885 | *0043 | *0195 | *0343 | *0485 |
| 23 | 7324 | 8573 | 8987 | 9365 | 9713 | 9876 | *0034 | *0187 | *0334 | *0476 |
| 24 | 9·7314 | 8564 | 8978 | 9356 | 9703 | 9867 | *0025 | *0177 | *0325 | *0467 |
| 25 | 7305 | 8555 | 8968 | 9346 | 9694 | 9858 | *0016 | *0168 | *0315 | *0458 |
| 26 | 7296 | 8545 | 8959 | 9337 | 9684 | 9848 | *0006 | *0159 | *0306 | *0448 |
| 27 | 9·7286 | 8536 | 8950 | 9327 | 9675 | 9839 | 9997 | *0149 | *0297 | *0439 |
| 28 | 7277 | 8527 | 8941 | 9319 | 9667 | 9830 | 9988 | *0141 | *0288 | *0430 |
| 29 | 7268 | 8517 | 8932 | 9309 | 9657 | 9821 | 9979 | *0131 | *0278 | *0421 |
| 30 | 9·7259 | 8508 | 8922 | 9300 | 9647 | 9811 | 9969 | *0122 | *0269 | *0412 |
| 31 | 7250 | 8499 | 8913 | 9291 | 9639 | 9803 | 9961 | *0113 | *0260 | *0403 |
| 32 | 7240 | 8490 | 8904 | 9281 | 9629 | 9793 | 9951 | *0103 | *0251 | *0393 |
| 33 | 9·7232 | 8481 | 8895 | 9273 | 9620 | 9785 | 9942 | *0095 | *0242 | *0384 |
| 34 | 7222 | 8471 | 8886 | 9263 | 9611 | 9775 | 9933 | *0085 | *0233 | *0375 |
| 35 | 7214 | 8463 | 8877 | 9255 | 9602 | 9766 | 9924 | *0077 | *0224 | *0366 |
| 36 | 9·7204 | 8454 | 8868 | 9246 | 9593 | 9757 | 9915 | *0068 | *0215 | *0357 |
| 37 | 7195 | 8444 | 8858 | 9236 | 9584 | 9747 | 9906 | *0058 | *0205 | *0347 |
| 38 | 7186 | 8435 | 8850 | 9227 | 9575 | 9739 | 9897 | *0049 | *0197 | *0339 |
| 39 | 9·7176 | 8426 | 8840 | 9218 | 9565 | 9729 | 9887 | *0039 | *0187 | *0329 |
| 40 | 7168 | 8418 | 8832 | 9210 | 9557 | 9721 | 9879 | *0032 | *0179 | *0321 |
| 41 | 7160 | 8409 | 8823 | 9201 | 9548 | 9712 | 9870 | *0023 | *0170 | *0312 |
| 42 | 9·7150 | 8399 | 8813 | 9191 | 9539 | 9703 | 9861 | *0013 | *0160 | *0302 |
| 43 | 7142 | 8391 | 8805 | 9183 | 9530 | 9694 | 9852 | *0005 | *0152 | *0294 |
| 44 | 7132 | 8382 | 8795 | 9173 | 9521 | 9685 | 9843 | 9995 | *0142 | *0284 |
| 45 | 9·7124 | 8373 | 8787 | 9165 | 9512 | 9676 | 9834 | 9987 | *0134 | *0276 |
| 46 | 7114 | 8363 | 8777 | 9155 | 9503 | 9667 | 9825 | 9977 | *0124 | *0267 |
| 47 | 7105 | 8354 | 8768 | 9146 | 9494 | 9658 | 9815 | 9968 | *0115 | *0258 |
| 48 | 9·7097 | 8346 | 8760 | 9138 | 9486 | 9650 | 9807 | 9960 | *0107 | *0249 |
| 49 | 7087 | 8337 | 8750 | 9128 | 9476 | 9640 | 9798 | 9950 | *0097 | *0240 |
| 50 | 7078 | 8327 | 8741 | 9119 | 9466 | 9631 | 9789 | 9941 | *0088 | *0230 |
| 51 | 9·7070 | 8319 | 8733 | 9111 | 9459 | 9622 | 9780 | 9933 | *0080 | *0222 |
| 52 | 7061 | 8311 | 8724 | 9103 | 9450 | 9614 | 9772 | 9925 | *0072 | *0214 |
| 53 | 7052 | 8301 | 8716 | 9093 | 9441 | 9605 | 9763 | 9915 | *0063 | *0205 |

XX. (*continued*).

| Temperature | 15 in. | 20 in. | 22 in. | 24 in. | 26 in. | 27 in. | 28 in. | 29 in. | 30 in. | 31 in. |
|---|---|---|---|---|---|---|---|---|---|---|
| F | | | | | | | | | | |
| 54° | 9·7042 | 8292 | 8706 | 9083 | 9431 | 9595 | 9753 | 9905 | *0053 | *0195 |
| 55 | 7033 | 8283 | 8696 | 9074 | 9422 | 9586 | 9744 | 9896 | *0043 | *0186 |
| 56 | 7024 | 8273 | 8687 | 9065 | 9413 | 9577 | 9735 | 9887 | *0034 | *0177 |
| 57 | 9·7015 | 8264 | 8678 | 9056 | 9404 | 9567 | 9725 | 9878 | *0025 | *0167 |
| 58 | 7007 | 8256 | 8670 | 9048 | 9395 | 9559 | 9717 | 9870 | *0017 | *0159 |
| 59 | 6997 | 8246 | 8661 | 9038 | 9386 | 9550 | 9708 | 9860 | *0007 | *0150 |
| 60 | 9·6988 | 8237 | 8651 | 9029 | 9377 | 9540 | 9699 | 9851 | 9998 | *0141 |
| 61 | 6980 | 8229 | 8643 | 9021 | 9368 | 9532 | 9690 | 9843 | 9990 | *0132 |
| 62 | 6970 | 8220 | 8633 | 9011 | 9359 | 9523 | 9681 | 9833 | 9980 | *0123 |
| 63 | 9·6961 | 8211 | 8624 | 9002 | 9350 | 9514 | 9672 | 9824 | 9971 | *0114 |
| 64 | 6952 | 8201 | 8615 | 8993 | 9340 | 9504 | 9662 | 9815 | 9962 | *0104 |
| 65 | 6942 | 8191 | 8606 | 8983 | 9331 | 9495 | 9653 | 9805 | 9952 | *0095 |
| 66 | 9·6934 | 8183 | 8597 | 8975 | 9323 | 9487 | 9644 | 9797 | 9944 | *0086 |
| 67 | 6925 | 8174 | 8588 | 8965 | 9313 | 9477 | 9635 | 9787 | 9935 | *0077 |
| 68 | 6916 | 8165 | 8579 | 8957 | 9304 | 9468 | 9627 | 9779 | 9926 | *0069 |
| 69 | 9·6907 | 8156 | 8570 | 8948 | 9296 | 9460 | 9618 | 9770 | 9918 | *0060 |
| 70 | 6898 | 8147 | 8561 | 8939 | 9287 | 9450 | 9609 | 9761 | 9908 | *0051 |
| 71 | 6888 | 8138 | 8552 | 8929 | 9277 | 9441 | 9599 | 9752 | 9899 | *0041 |
| 72 | 9·6880 | 8129 | 8543 | 8921 | 9269 | 9432 | 9590 | 9743 | 9890 | *0032 |
| 73 | 6871 | 8120 | 8535 | 8912 | 9260 | 9424 | 9582 | 9734 | 9882 | *0024 |
| 74 | 6862 | 8111 | 8526 | 8904 | 9251 | 9415 | 9573 | 9726 | 9873 | *0015 |
| 75 | 9·6853 | 8102 | 8516 | 8894 | 9242 | 9406 | 9564 | 9716 | 9863 | *0006 |
| 76 | 6843 | 8093 | 8506 | 8885 | 9232 | 9396 | 9554 | 9706 | 9853 | 9996 |
| 77 | 6835 | 8084 | 8498 | 8876 | 9224 | 9387 | 9545 | 9698 | 9845 | 9987 |
| 78 | 9·6825 | 8075 | 8488 | 8866 | 9214 | 9378 | 9536 | 9688 | 9835 | 9978 |
| 79 | 6816 | 8066 | 8479 | 8858 | 9205 | 9369 | 9527 | 9679 | 9827 | 9969 |
| 80 | 6807 | 8056 | 8470 | 8848 | 9195 | 9359 | 9517 | 9670 | 9817 | 9959 |
| 81 | 9·6797 | 8046 | 8460 | 8838 | 9186 | 9350 | 9508 | 9660 | 9807 | 9950 |
| 82 | 6788 | 8037 | 8452 | 8829 | 9177 | 9341 | 9499 | 9651 | 9799 | 9941 |
| 83 | 6779 | 8029 | 8443 | 8821 | 9168 | 9332 | 9490 | 9643 | 9790 | 9932 |
| 84 | 9·6771 | 8020 | 8434 | 8812 | 9159 | 9323 | 9481 | 9634 | 9781 | 9923 |
| 85 | 6761 | 8011 | 8424 | 8802 | 9150 | 9314 | 9471 | 9624 | 9771 | 9914 |
| 86 | 6752 | 8001 | 8415 | 8793 | 9141 | 9304 | 9463 | 9615 | 9762 | 9905 |
| 87 | 9·6743 | 7993 | 8406 | 8784 | 9132 | 9296 | 9454 | 9606 | 9753 | 9896 |
| 88 | 6733 | 7982 | 8397 | 8774 | 9122 | 9286 | 9444 | 9596 | 9744 | 9886 |
| 89 | 6724 | 7973 | 8388 | 8766 | 9113 | 9277 | 9435 | 9588 | 9735 | 9877 |
| 90 | 9·6715 | 7964 | 8378 | 8756 | 9104 | 9268 | 9426 | 9578 | 9726 | 9868 |
| 91 | 6706 | 7955 | 8369 | 8747 | 9094 | 9258 | 9416 | 9568 | 9716 | 9858 |
| 92 | 6695 | 7945 | 8359 | 8737 | 9084 | 9248 | 9406 | 9559 | 9706 | 9848 |
| 93 | 9·6687 | 7936 | 8350 | 8728 | 9075 | 9239 | 9397 | 9550 | 9697 | 9839 |
| 94 | 6677 | 7926 | 8340 | 8718 | 9066 | 9229 | 9387 | 9540 | 9687 | 9829 |
| 95 | 6668 | 7917 | 8331 | 8709 | 9056 | 9220 | 9378 | 9531 | 9678 | 9820 |
| 96 | 9·6658 | 7907 | 8321 | 8699 | 9047 | 9210 | 9368 | 9521 | 9668 | 9810 |
| 97 | 6647 | 7897 | 8311 | 8689 | 9036 | 9200 | 9358 | 9510 | 9658 | 9800 |
| 98 | 6637 | 7887 | 8301 | 8679 | 9027 | 9190 | 9349 | 9501 | 9648 | 9790 |
| 99 | 9·6628 | 7878 | 8291 | 8669 | 9016 | 9180 | 9338 | 9490 | 9638 | 9780 |
| 100 | 9·6619 | 7868 | 8281 | 8659 | 9007 | 9171 | 9329 | 9482 | 9629 | 9771 |

## XXI.

Log $\tau$ for various heights, gravity and temperature being supposed constant.

| Ht. | 000 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 |
|---|---|---|---|---|---|---|---|---|---|---|
| Feet | | | | | | | | | | |
| 39 | 9·4646 | 4630 | 4615 | 4599 | 4583 | 4568 | 4552 | 4537 | 4521 | 4505 |
| 38 | 4802 | 4786 | 4771 | 4755 | 4739 | 4724 | 4708 | 4693 | 4677 | 4661 |
| 37 | 4958 | 4942 | 4927 | 4911 | 4895 | 4880 | 4864 | 4849 | 4833 | 4817 |
| 36 | 5114 | 5098 | 5083 | 5067 | 5051 | 5036 | 5020 | 5005 | 4989 | 4973 |
| 35 | 9·5270 | 5254 | 5239 | 5223 | 5207 | 5192 | 5176 | 5161 | 5145 | 5129 |
| 34 | 5426 | 5410 | 5394 | 5379 | 5363 | 5348 | 5332 | 5316 | 5301 | 5285 |
| 33 | 5582 | 5566 | 5550 | 5535 | 5519 | 5504 | 5488 | 5472 | 5457 | 5441 |
| 32 | 9·5738 | 5722 | 5706 | 5691 | 5675 | 5660 | 5644 | 5628 | 5613 | 5597 |
| 31 | 5894 | 5878 | 5862 | 5847 | 5831 | 5816 | 5800 | 5784 | 5769 | 5753 |
| 30 | 6050 | 6034 | 6018 | 6003 | 5987 | 5972 | 5956 | 5940 | 5925 | 5909 |
| 29 | 9·6206 | 6190 | 6174 | 6159 | 6143 | 6128 | 6112 | 6096 | 6081 | 6065 |
| 28 | 6362 | 6346 | 6330 | 6315 | 6299 | 6284 | 6268 | 6252 | 6237 | 6221 |
| 27 | 6518 | 6502 | 6486 | 6471 | 6455 | 6440 | 6424 | 6408 | 6393 | 6377 |
| 26 | 9·6674 | 6658 | 6642 | 6627 | 6611 | 6596 | 6580 | 6564 | 6549 | 6533 |
| 25 | 6830 | 6814 | 6798 | 6783 | 6767 | 6752 | 6736 | 6720 | 6705 | 6689 |
| 24 | 6985 | 6970 | 6954 | 6939 | 6923 | 6907 | 6892 | 6876 | 6861 | 6845 |
| 23 | 9·7141 | 7126 | 7110 | 7095 | 7079 | 7063 | 7048 | 7032 | 7016 | 7001 |
| 22 | 7297 | 7282 | 7266 | 7251 | 7235 | 7219 | 7204 | 7188 | 7173 | 7157 |
| 21 | 7453 | 7438 | 7422 | 7407 | 7391 | 7375 | 7360 | 7344 | 7329 | 7313 |
| 20 | 9·7609 | 7594 | 7578 | 7563 | 7547 | 7531 | 7516 | 7500 | 7485 | 7469 |
| 19 | 7765 | 7750 | 7734 | 7719 | 7703 | 7687 | 7672 | 7656 | 7641 | 7625 |
| 18 | 7921 | 7906 | 7890 | 7875 | 7859 | 7843 | 7828 | 7812 | 7797 | 7781 |
| 17 | 9·8077 | 8062 | 8046 | 8031 | 8015 | 7999 | 7984 | 7968 | 7953 | 7937 |
| 16 | 8233 | 8218 | 8202 | 8187 | 8171 | 8155 | 8140 | 8124 | 8109 | 8093 |
| 15 | 8389 | 8374 | 8358 | 8343 | 8327 | 8311 | 8296 | 8280 | 8265 | 8249 |
| 14 | 9·8545 | 8530 | 8514 | 8498 | 8483 | 8467 | 8452 | 8436 | 8420 | 8405 |
| 13 | 8701 | 8686 | 8670 | 8654 | 8639 | 8623 | 8608 | 8592 | 8576 | 8561 |
| 12 | 8857 | 8842 | 8826 | 8810 | 8795 | 8779 | 8764 | 8748 | 8732 | 8717 |
| 11 | 9·9013 | 8998 | 8982 | 8966 | 8951 | 8935 | 8920 | 8904 | 8888 | 8873 |
| 10 | 9169 | 9154 | 9138 | 9122 | 9107 | 9091 | 9076 | 9060 | 9044 | 9029 |
| 9 | 9325 | 9310 | 9294 | 9278 | 9263 | 9247 | 9232 | 9216 | 9200 | 9185 |
| 8 | 9·9481 | 9466 | 9450 | 9434 | 9419 | 9403 | 9388 | 9372 | 9357 | 9341 |
| 7 | 9637 | 9622 | 9606 | 9590 | 9575 | 9559 | 9544 | 9528 | 9512 | 9497 |
| 6 | 9793 | 9778 | 9762 | 9746 | 9731 | 9715 | 9700 | 9684 | 9668 | 9653 |
| 5 | 9·9949 | 9934 | 9918 | 9902 | 9887 | 9871 | 9856 | 9840 | 9824 | 9809 |
| 4 | 0·0105 | 0089 | 0074 | 0058 | 0043 | 0027 | 0011 | *9996 | *9980 | *9965 |
| 3 | 0261 | 0245 | 0230 | 0214 | 0199 | 0183 | 0167 | 0152 | 0136 | 0121 |
| 2 | 0·0417 | 0401 | 0386 | 0370 | 0355 | 0339 | 0323 | 0308 | 0292 | 0277 |
| 1 | 0573 | 0557 | 0542 | 0526 | 0511 | 0495 | 0479 | 0464 | 0448 | 0433 |
| 0 | 0729 | 0713 | 0698 | 0682 | 0667 | 0651 | 0635 | 0620 | 0604 | 0589 |
| Feet | 0 | +10 | +20 | +30 | +40 | +50 | +60 | +70 | +80 | +90 |
| Diff. in Log $\tau$ | 0 | −·0002 | −·0003 | −·0005 | −·0006 | −·0008 | −·0009 | −·0011 | −·0013 | −·0014 |

## XXII. (1) Spherical Projectiles.

| $v$ | 2 in. | 3 in. | 4 in. | 5 in. | 6 in. | 7 in. | 8 in. | 9 in. | 10 in. | 11 in. | 12 in. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 900 | 13 | 29 | 51 | 80 | 115 | 156 | 204 | 258 | 319 | 386 | 459 |
| 1000 | 18 | 40 | 71 | 110 | 159 | 216 | 282 | 357 | 441 | 534 | 635 |
| 1100 | 25 | 57 | 102 | 159 | 229 | 312 | 408 | 516 | 637 | 771 | 917 |
| 1200 | 33 | 75 | 134 | 209 | 301 | 409 | 534 | 676 | 835 | 1010 | 1202 |
| 1300 | 41 | 91 | 162 | 254 | 365 | 497 | 649 | 822 | 1015 | 1228 | 1461 |
| 1400 | 48 | 109 | 194 | 303 | 436 | 593 | 775 | 981 | 1211 | 1466 | 1744 |
| 1500 | 57 | 128 | 227 | 355 | 511 | 695 | 908 | 1149 | 1419 | 1716 | 2043 |
| 1600 | 65 | 147 | 261 | 408 | 588 | 800 | 1045 | 1322 | 1633 | 1976 | 2351 |
| 1700 | 74 | 167 | 296 | 463 | 666 | 907 | 1185 | 1499 | 1851 | 2240 | 2666 |
| 1800 | 83 | 187 | 332 | 518 | 746 | 1016 | 1327 | 1679 | 2073 | 2508 | 2985 |
| 1900 | 93 | 209 | 371 | 580 | 835 | 1137 | 1485 | 1880 | 2320 | 2808 | 3341 |
| 2000 | 104 | 235 | 417 | 652 | 939 | 1278 | 1669 | 2112 | 2607 | 3155 | 3754 |
| 2100 | 115 | 259 | 460 | 718 | 1035 | 1408 | 1839 | 2328 | 2874 | 3477 | 4138 |
| 2200 | 125 | 281 | 500 | 781 | 1124 | 1530 | 1999 | 2530 | 3123 | 3779 | 4497 |

## (2) Ogival-headed Projectiles ($1\frac{1}{2}$ diameter).

| *f. s.* | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 0·1 | 0·2 | 0·3 | 0·5 | 0·7 | 0·9 | 1·2 | 1·5 | 1·9 | 2·3 | 2·7 |
| 200 | 0·3 | 0·7 | 1·2 | 1·9 | 2·7 | 3·7 | 4·8 | 6·1 | 7·5 | 9·1 | 10·8 |
| 300 | 0·7 | 1·5 | 2·7 | 4·2 | 6·1 | 8·3 | 10·8 | 13·7 | 16·9 | 20·4 | 24·3 |
| 400 | 1·2 | 2·7 | 4·8 | 7·5 | 10·8 | 14·7 | 19·3 | 24·4 | 30·1 | 36·4 | 43·3 |
| 500 | 1·9 | 4·2 | 7·5 | 11·8 | 16·9 | 23·0 | 30·1 | 38·1 | 47·0 | 56·9 | 67·7 |
| 600 | 2·7 | 6·1 | 10·8 | 16·9 | 24·3 | 33·1 | 43·3 | 54·8 | 67·6 | 81·8 | 97·3 |
| 700 | 3·7 | 8·3 | 14·7 | 23·0 | 33·2 | 45·1 | 58·9 | 74·6 | 92·1 | 111·4 | 132·6 |
| 800 | 4·8 | 10·8 | 19·2 | 30·1 | 43·3 | 58·9 | 76·9 | 97·4 | 120·2 | 145·4 | 173·1 |
| 900 | 6·7 | 15·0 | 26·7 | 41·7 | 60·0 | 81·6 | 106·6 | 134·9 | 166·6 | 201·6 | 239·9 |
| 1000 | 9·1 | 20·6 | 36·6 | 57·2 | 82·3 | 112·0 | 146·3 | 185·2 | 228·6 | 276·6 | 329·2 |
| 1100 | 17·7 | 39·8 | 70·7 | 110·5 | 159·1 | 216·6 | 282·9 | 358·0 | 442·0 | 534·8 | 636·5 |
| 1200 | 24 | 53 | 94 | 147 | 212 | 288 | 377 | 477 | 588 | 712 | 847 |
| 1300 | 30 | 67 | 119 | 187 | 269 | 366 | 478 | 605 | 747 | 903 | 1075 |
| 1400 | 36 | 81 | 143 | 224 | 323 | 439 | 574 | 726 | 897 | 1085 | 1291 |
| 1500 | 41 | 93 | 165 | 258 | 371 | 506 | 660 | 836 | 1032 | 1248 | 1486 |
| 1600 | 46 | 104 | 184 | 288 | 415 | 564 | 737 | 933 | 1151 | 1393 | 1658 |
| 1700 | 51 | 115 | 204 | 319 | 459 | 624 | 816 | 1032 | 1274 | 1542 | 1835 |
| 1800 | 56 | 126 | 224 | 351 | 505 | 687 | 897 | 1136 | 1402 | 1696 | 2019 |
| 1900 | 62 | 138 | 246 | 385 | 554 | 754 | 985 | 1246 | 1539 | 1862 | 2215 |
| 2000 | 68 | 153 | 272 | 426 | 613 | 834 | 1090 | 1379 | 1702 | 2060 | 2451 |
| 2100 | 77 | 173 | 308 | 482 | 694 | 944 | 1233 | 1561 | 1927 | 2332 | 2775 |
| 2200 | 87 | 196 | 348 | 544 | 784 | 1066 | 1393 | 1763 | 2177 | 2634 | 3134 |
| 2300 | 94 | 212 | 376 | 588 | 846 | 1152 | 1504 | 1904 | 2351 | 2844 | 3385 |
| 2400 | 98 | 220 | 392 | 612 | 881 | 1200 | 1567 | 1983 | 2448 | 2962 | 3525 |
| 2500 | 103 | 231 | 411 | 642 | 924 | 1258 | 1643 | 2079 | 2567 | 3106 | 3697 |
| 2600 | 112 | 253 | 450 | 703 | 1012 | 1378 | 1800 | 2278 | 2812 | 3403 | 4050 |
| 2700 | 126 | 282 | 502 | 784 | 1130 | 1537 | 2008 | 2541 | 3138 | 3796 | 4518 |
| 2800 | 140 | 314 | 559 | 873 | 1257 | 1711 | 2235 | 2829 | 3493 | 4226 | 5029 |

## XXIII. $S_v$ for Spherical Projectiles, ($w = 534{\cdot}22$ grams).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 40 | 150 | 171 | 192 | 213 | 234 | 255 | 276 | 296 | 317 | 338 | 21 |
| 41 | 359 | 379 | 400 | 420 | 441 | 461 | 481 | 501 | 522 | 542 | 20 |
| 42 | 562 | 582 | 602 | 622 | 642 | 662 | 682 | 702 | 722 | 742 | 20 |
| 43 | 761 | 781 | 800 | 820 | 839 | 859 | 878 | 897 | 917 | 936 | 19 |
| 44 | 955 | 974 | 994 | 1013 | 1032 | 1051 | 1070 | 1089 | 1108 | 1127 | 19 |
| 45 | 1146 | 1164 | 1183 | 1202 | 1221 | 1239 | 1258 | 1276 | 1295 | 1313 | 19 |
| 46 | 1331 | 1350 | 1368 | 1387 | 1405 | 1423 | 1441 | 1459 | 1477 | 1495 | 18 |
| 47 | 1513 | 1531 | 1549 | 1567 | 1585 | 1602 | 1620 | 1638 | 1656 | 1673 | 18 |
| 48 | 1691 | 1709 | 1726 | 1744 | 1761 | 1779 | 1796 | 1814 | 1831 | 1848 | 17 |
| 49 | 1866 | 1883 | 1900 | 1917 | 1934 | 1951 | 1968 | 1985 | 2002 | 2019 | 17 |
| 50 | 2036 | 2053 | 2070 | 2086 | 2103 | 2120 | 2137 | 2154 | 2171 | 2188 | 17 |
| 51 | 2204 | 2221 | 2237 | 2254 | 2270 | 2287 | 2303 | 2319 | 2336 | 2352 | 16 |
| 52 | 2368 | 2384 | 2401 | 2417 | 2433 | 2449 | 2465 | 2481 | 2497 | 2513 | 16 |
| 53 | 2529 | 2545 | 2561 | 2577 | 2593 | 2608 | 2624 | 2640 | 2656 | 2671 | 16 |
| 54 | 2687 | 2703 | 2718 | 2734 | 2749 | 2765 | 2780 | 2796 | 2811 | 2827 | 16 |
| 55 | 2842 | 2858 | 2873 | 2888 | 2904 | 2919 | 2934 | 2949 | 2965 | 2980 | 15 |
| 56 | 2995 | 3010 | 3025 | 3040 | 3055 | 3070 | 3085 | 3099 | 3114 | 3129 | 15 |
| 57 | 3144 | 3159 | 3174 | 3189 | 3204 | 3218 | 3233 | 3248 | 3262 | 3277 | 15 |
| 58 | 3291 | 3306 | 3320 | 3335 | 3349 | 3364 | 3378 | 3393 | 3407 | 3421 | 14 |
| 59 | 3436 | 3450 | 3464 | 3478 | 3493 | 3507 | 3521 | 3535 | 3550 | 3564 | 14 |
| 60 | 3578 | 3592 | 3606 | 3620 | 3634 | 3648 | 3662 | 3676 | 3690 | 3704 | 14 |
| 61 | 3718 | 3731 | 3745 | 3759 | 3773 | 3786 | 3800 | 3814 | 3828 | 3841 | 14 |
| 62 | 3855 | 3869 | 3883 | 3896 | 3910 | 3924 | 3937 | 3951 | 3964 | 3977 | 14 |
| 63 | 3991 | 4004 | 4017 | 4031 | 4044 | 4058 | 4071 | 4084 | 4098 | 4111 | 13 |
| 64 | 4124 | 4137 | 4150 | 4163 | 4176 | 4189 | 4203 | 4216 | 4229 | 4242 | 13 |
| 65 | 4255 | 4268 | 4281 | 4294 | 4307 | 4319 | 4332 | 4345 | 4358 | 4371 | 13 |
| 66 | 4384 | 4397 | 4410 | 4422 | 4435 | 4448 | 4461 | 4473 | 4486 | 4499 | 13 |
| 67 | 4511 | 4524 | 4536 | 4549 | 4561 | 4574 | 4586 | 4599 | 4611 | 4624 | 13 |
| 68 | 4636 | 4649 | 4661 | 4674 | 4686 | 4698 | 4711 | 4723 | 4735 | 4747 | 12 |
| 69 | 4760 | 4772 | 4784 | 4796 | 4809 | 4821 | 4833 | 4845 | 4857 | 4869 | 12 |
| 70 | 4881 | 4893 | 4905 | 4917 | 4929 | 4941 | 4953 | 4965 | 4977 | 4989 | 12 |
| 71 | 5001 | 5013 | 5025 | 5037 | 5049 | 5060 | 5072 | 5084 | 5096 | 5107 | 12 |
| 72 | 5119 | 5131 | 5143 | 5154 | 5166 | 5178 | 5190 | 5201 | 5213 | 5225 | 12 |
| 73 | 5236 | 5248 | 5259 | 5271 | 5282 | 5294 | 5305 | 5317 | 5328 | 5340 | 12 |
| 74 | 5351 | 5363 | 5374 | 5385 | 5397 | 5408 | 5420 | 5431 | 5442 | 5453 | 11 |
| 75 | 5465 | 5476 | 5487 | 5498 | 5510 | 5521 | 5532 | 5543 | 5555 | 5566 | 11 |
| 76 | 5577 | 5588 | 5599 | 5610 | 5621 | 5632 | 5643 | 5654 | 5665 | 5676 | 11 |
| 77 | 5687 | 5698 | 5709 | 5720 | 5731 | 5742 | 5753 | 5764 | 5775 | 5785 | 11 |
| 78 | 5796 | 5807 | 5818 | 5828 | 5839 | 5850 | 5861 | 5871 | 5882 | 5893 | 11 |
| 79 | 5904 | 5914 | 5925 | 5936 | 5947 | 5957 | 5968 | 5979 | 5989 | 6000 | 11 |
| 80 | 6010 | 6021 | 6031 | 6042 | 6052 | 6063 | 6073 | 6084 | 6094 | 6105 | 11 |
| 81 | 6115 | 6126 | 6136 | 6147 | 6157 | 6168 | 6178 | 6188 | 6199 | 6209 | 10 |
| 82 | 6219 | 6229 | 6240 | 6250 | 6260 | 6270 | 6281 | 6291 | 6301 | 6311 | 10 |
| 83 | 6322 | 6332 | 6342 | 6352 | 6362 | 6372 | 6382 | 6392 | 6403 | 6413 | 10 |
| 84 | 6423 | 6433 | 6443 | 6453 | 6463 | 6473 | 6483 | 6493 | 6503 | 6512 | 10 |
| 85 | 6522 | 6532 | 6542 | 6552 | 6561 | 6571 | 6581 | 6591 | 6600 | 6610 | 10 |
| 86 | 6619 | 6629 | 6639 | 6648 | 6658 | 6667 | 6677 | 6686 | 6696 | 6705 | 10 |
| 87 | 6714 | 6724 | 6733 | 6742 | 6752 | 6761 | 6770 | 6779 | 6789 | 6798 | 9 |
| 88 | 6807 | 6816 | 6825 | 6835 | 6844 | 6853 | 6862 | 6871 | 6880 | 6889 | 9 |
| 89 | 6898 | 6907 | 6916 | 6925 | 6933 | 6942 | 6951 | 6960 | 6969 | 6978 | 9 |
| 90 | 6986 | 6995 | 7004 | 7013 | 7021 | 7030 | 7039 | 7046 | 7056 | 7064 | 9 |

## XXIII. $S_v$ for Spherical Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 91 | 7073 | 7082 | 7090 | 7099 | 7107 | 7116 | 7124 | 7133 | 7141 | 7149 | 8 |
| 92 | 7158 | 7166 | 7175 | 7183 | 7191 | 7200 | 7208 | 7216 | 7225 | 7233 | 8 |
| 93 | 7241 | 7249 | 7257 | 7266 | 7274 | 7282 | 7290 | 7298 | 7306 | 7314 | 8 |
| 94 | 7322 | 7330 | 7338 | 7346 | 7354 | 7362 | 7370 | 7378 | 7386 | 7394 | 8 |
| 95 | 7402 | 7409 | 7417 | 7425 | 7433 | 7441 | 7448 | 7456 | 7464 | 7472 | 8 |
| 96 | 7479 | 7487 | 7495 | 7502 | 7510 | 7518 | 7525 | 7533 | 7541 | 7548 | 8 |
| 97 | 7556 | 7563 | 7571 | 7578 | 7586 | 7593 | 7601 | 7608 | 7615 | 7623 | 7 |
| 98 | 7630 | 7638 | 7645 | 7652 | 7660 | 7667 | 7674 | 7681 | 7689 | 7696 | 7 |
| 99 | 7703 | 7710 | 7717 | 7725 | 7732 | 7739 | 7746 | 7753 | 7760 | 7767 | 7 |
| 100 | 7774 | 7781 | 7788 | 7795 | 7802 | 7809 | 7816 | 7823 | 7830 | 7837 | 7 |
| 101 | 7844 | 7851 | 7858 | 7864 | 7871 | 7878 | 7885 | 7892 | 7898 | 7905 | 7 |
| 102 | 7912 | 7918 | 7925 | 7932 | 7938 | 7945 | 7951 | 7958 | 7964 | 7971 | 7 |
| 103 | 7977 | 7984 | 7990 | 7997 | 8003 | 8010 | 8016 | 8022 | 8029 | 8035 | 6 |
| 104 | 8041 | 8047 | 8053 | 8060 | 8066 | 8072 | 8078 | 8084 | 8091 | 8097 | 6 |
| 105 | 8103 | 8109 | 8115 | 8121 | 8127 | 8133 | 8139 | 8145 | 8151 | 8157 | 6 |
| 106 | 8163 | 8169 | 8175 | 8180 | 8186 | 8192 | 8198 | 8204 | 8209 | 8215 | 6 |
| 107 | 8221 | 8227 | 8233 | 8238 | 8244 | 8250 | 8256 | 8261 | 8267 | 8272 | 6 |
| 108 | 8278 | 8284 | 8289 | 8295 | 8300 | 8306 | 8312 | 8317 | 8323 | 8328 | 6 |
| 109 | 8334 | 8339 | 8345 | 8350 | 8356 | 8361 | 8366 | 8372 | 8377 | 8383 | 5 |
| 110 | 8 387·8 | 393·1 | 398·4 | 403·8 | 409·1 | 414·4 | 419·7 | 425·0 | 430·2 | 435·5 | 5·3 |
| 111 | 8 440·8 | 446·0 | 451·2 | 456·5 | 461·7 | 466·9 | 472·1 | 477·2 | 482·4 | 487·5 | 5·2 |
| 112 | 492·7 | 497·8 | 502·9 | 508·1 | 513·2 | 518·3 | 523·4 | 528·4 | 533·5 | 538·5 | 5·1 |
| 113 | 543·6 | 548·6 | 553·6 | 558·7 | 563·7 | 568·7 | 573·7 | 578·6 | 583·6 | 588·5 | 5·0 |
| 114 | 593·5 | 598·4 | 603·3 | 608·3 | 613·2 | 618·1 | 623·0 | 627·9 | 632·7 | 637·6 | 4·9 |
| 115 | 642·5 | 647·3 | 652·1 | 657·0 | 661·8 | 666·6 | 671·4 | 676·2 | 680·9 | 685·7 | 4·8 |
| 116 | 8 690·5 | 695·3 | 700·0 | 704·8 | 709·5 | 714·3 | 719·0 | 723·7 | 728·4 | 733·1 | 4·7 |
| 117 | 737·8 | 742·5 | 747·1 | 751·8 | 756·4 | 761·1 | 765·7 | 770·3 | 775·0 | 779·6 | 4·6 |
| 118 | 784·2 | 788·8 | 793·4 | 797·9 | 802·5 | 807·1 | 811·7 | 816·2 | 820·8 | 825·3 | 4·6 |
| 119 | 829·9 | 834·4 | 838·9 | 843·5 | 848·0 | 852·5 | 857·0 | 861·5 | 865·9 | 870·4 | 4·5 |
| 120 | 874·9 | 879·3 | 883·8 | 888·2 | 892·7 | 897·1 | 901·5 | 905·9 | 910·4 | 914·8 | 4·4 |
| 121 | 8 919·2 | 923·6 | 928·0 | 932·4 | 936·8 | 941·2 | 945·6 | 949·9 | 954·3 | 958·6 | 4·4 |
| 122 | 963·0 | 967·3 | 971·6 | 976·0 | 980·3 | 984·6 | 988·9 | 993·2 | 997·5 | ·001·8 | 4·3 |
| 123 | 9 006·1 | 010·4 | 014·7 | 019·0 | 023·3 | ·027·6 | 031·9 | 036·1 | 040·4 | 044·6 | 4·3 |
| 124 | 048·9 | 053·1 | 057·3 | 061·5 | 065·7 | 069·9 | 074·1 | 078·3 | 082·5 | 086·7 | 4·2 |
| 125 | 090·9 | 095·1 | 099·3 | 103·5 | 107·7 | 111·9 | 116·1 | 120·2 | 124·4 | 128·5 | 4·1 |
| 126 | 9 132·7 | 136·8 | 140·9 | 145·1 | 149·2 | 153·3 | 157·4 | 161·5 | 165·6 | 169·7 | 4·1 |
| 127 | 173·8 | 177·9 | 182·0 | 186·1 | 190·2 | 194·3 | 198·4 | 202·4 | 206·5 | 210·5 | 4·1 |
| 128 | 214·6 | 218·6 | 222·7 | 226·7 | 230·8 | 234·8 | 238·8 | 242·8 | 246·9 | 250·9 | 4·0 |
| 129 | 254·9 | 258·9 | 262·9 | 267·0 | 271·0 | 275·0 | 279·0 | 283·0 | 286·9 | 290·9 | 4·0 |
| 130 | 294·9 | 298·9 | 302·9 | 306·8 | 310·8 | 314·8 | 318·8 | 322·7 | 326·7 | 330·6 | 4·0 |
| 131 | 9 334·6 | 338·5 | 342·4 | 346·4 | 350·3 | 354·2 | 358·1 | 362·0 | 365·9 | 369·8 | 3·9 |
| 132 | 373·7 | 377·6 | 381·5 | 385·4 | 389·3 | 393·2 | 397·1 | 400·9 | 404·8 | 408·6 | 3·9 |
| 133 | 412·5 | 416·4 | 420·2 | 424·1 | 427·9 | 431·8 | 435·6 | 439·4 | 443·3 | 447·1 | 3·8 |
| 134 | 450·9 | 454·7 | 458·5 | 462·3 | 466·1 | 469·9 | 473·7 | 477·5 | 481·2 | 485·0 | 3·8 |
| 135 | 488·8 | 492·6 | 496·4 | 500·1 | 503·9 | 507·7 | 511·4 | 515·2 | 518·9 | 522·7 | 3·8 |
| 136 | 9 526·4 | 530·1 | 533·8 | 537·6 | 541·3 | 545·0 | 548·7 | 552·4 | 556·1 | 559·8 | 3·7 |
| 137 | 563·5 | 567·2 | 570·9 | 574·6 | 578·3 | 582·0 | 585·7 | 589·3 | 593·0 | 596·6 | 3·7 |
| 138 | 600·3 | 604·0 | 607·6 | 611·3 | 614·9 | 618·6 | 622·2 | 625·9 | 629·5 | 633·2 | 3·7 |
| 139 | 636·8 | 640·4 | 644·0 | 647·7 | 651·3 | 654·9 | 658·5 | 662·1 | 665·7 | 669·3 | 3·6 |
| 140 | 672·9 | 676·5 | 680·1 | 683·6 | 687·2 | 690·8 | 694·4 | 697·9 | 701·5 | 705·0 | 3·6 |

## XXIII. $S_v$ for Spherical Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f.s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 141 | 9708·6 | 712·2 | 715·7 | 719·3 | 722·8 | 726·4 | 729·9 | 733·5 | 737·0 | 740·6 | 3·6 |
| 142 | 744·1 | 747·6 | 751·1 | 754·6 | 758·1 | 761·6 | 765·1 | 768·6 | 772·1 | 775·6 | 3·5 |
| 143 | 779·1 | 782·6 | 786·1 | 789·5 | 793·0 | 796·5 | 800·0 | 803·4 | 806·9 | 810·3 | 3·5 |
| 144 | 813·8 | 817·3 | 820·7 | 824·2 | 827·6 | 831·1 | 834·5 | 838·0 | 841·4 | 844·9 | 3·5 |
| 145 | 848·3 | 851·7 | 855·1 | 858·5 | 861·9 | 865·3 | 868·7 | 872·1 | 875·5 | 878·9 | 3·4 |
| 146 | 9882·3 | 885·7 | 889·1 | 892·5 | 895·9 | 899·3 | 902·7 | 906·1 | 909·4 | 912·8 | 3·4 |
| 147 | 916·2 | 919·6 | 922·9 | 926·3 | 929·6 | 933·0 | 936·3 | 939·7 | 943·0 | 946·4 | 3·4 |
| 148 | 949·7 | 953·0 | 956·4 | 959·7 | 963·1 | 966·4 | 969·7 | 973·0 | 976·4 | 979·7 | 3·3 |
| 149 | 983·0 | 986·3 | 989·6 | 992·9 | 996·2 | 999·5 | *002·8 | *006·1 | *009·4 | *012·7 | 3·3 |
| 150 | 10016·0 | 019·3 | 022·6 | 025·8 | 029·1 | 032 4 | 035·7 | 038·9 | 042·2 | 045·4 | 3·3 |
| 151 | 10048·7 | 051·9 | 055·2 | 058·4 | 061·7 | 064·9 | 068·1 | 071·4 | 074·6 | 077·9 | 3·2 |
| 152 | 081·1 | 084·3 | 087·6 | 090·8 | 094·1 | 097·3 | 100·5 | 103·7 | 106·9 | 110·1 | 3·2 |
| 153 | 113·3 | 116·5 | 119·7 | 122·9 | 126·1 | 129·3 | 132·5 | 135·7 | 138·9 | 142·1 | 3·2 |
| 154 | 145·3 | 148·5 | 151·7 | 154·8 | 158·0 | 161·2 | 164·4 | 167·5 | 170·7 | 173·8 | 3·2 |
| 155 | 177·0 | 180·1 | 183·3 | 186·4 | 189·6 | 192·7 | 195·8 | 199·0 | 202·1 | 205·3 | 3·1 |
| 156 | 10208·4 | 211·5 | 214·7 | 217·8 | 221·0 | 224·1 | 227·2 | 230·3 | 233·5 | 236·6 | 3·1 |
| 157 | 239·7 | 242·8 | 245·9 | 249·0 | 252·1 | 255·2 | 258·3 | 261·4 | 264·5 | 267·6 | 3·1 |
| 158 | 270·7 | 273·8 | 276·9 | 279·9 | 283·0 | 286·1 | 289·2 | 292·3 | 295·3 | 298·4 | 3·1 |
| 159 | 301·5 | 304·6 | 307·6 | 310·7 | 313·7 | 316·8 | 319·8 | 322·9 | 325·9 | 329·0 | 3·1 |
| 160 | 332·0 | 335·0 | 338·1 | 341·1 | 344·2 | 347·2 | 350·2 | 353·2 | 356·3 | 359·3 | 3·0 |
| 161 | 10362·3 | 365·3 | 368·3 | 371·4 | 374·4 | 377·4 | 380·4 | 383·4 | 386·4 | 389·4 | 3·0 |
| 162 | 392·4 | 395·4 | 398·4 | 401·4 | 404·4 | 407·4 | 410·4 | 413·4 | 416·4 | 419·4 | 3·0 |
| 163 | 422·4 | 425·4 | 428·4 | 431·3 | 434·3 | 437·3 | 440·3 | 443·2 | 446·2 | 449·1 | 3·0 |
| 164 | 452·1 | 455·1 | 458·0 | 461·0 | 463·9 | 466·9 | 469·8 | 472·8 | 475·7 | 478·7 | 2·9 |
| 165 | 481·6 | 484·5 | 487·5 | 490·4 | 493·4 | 496·3 | 499·2 | 502·2 | 505·1 | 508·1 | 2·9 |
| 166 | 10511·0 | 513·9 | 516·8 | 519·8 | 522·7 | 525·6 | 528·5 | 531·4 | 534·3 | 537·2 | 2·9 |
| 167 | 540·1 | 543·0 | 545·9 | 548·8 | 551·7 | 554·6 | 557·5 | 560·4 | 563·3 | 566·2 | 2·9 |
| 168 | 569·1 | 572·0 | 574·9 | 577·7 | 580·6 | 583·5 | 586·4 | 589·3 | 592·1 | 595·0 | 2·9 |
| 169 | 597·9 | 600 8 | 603·6 | 606·5 | 609·3 | 612·2 | 615·1 | 617·9 | 620·8 | 623·6 | 2·9 |
| 170 | 626·5 | 629·3 | 632·2 | 635·0 | 637·9 | 640·7 | 643·5 | 646·4 | 649·2 | 652·1 | 2·8 |
| 171 | 10654·9 | 657·7 | 660·6 | 663·4 | 666·3 | 669·1 | 671·9 | 674·7 | 677·6 | 680·4 | 2·8 |
| 172 | 683·2 | 686·0 | 688·8 | 691·7 | 694·5 | 697·3 | 700·1 | 702·9 | 705·7 | 708·5 | 2·8 |
| 173 | 711·2 | 714·1 | 716·9 | 719·7 | 722·5 | 725·3 | 728·1 | 730·9 | 733·7 | 736·5 | 2·8 |
| 174 | 739·3 | 742·1 | 744·9 | 747·6 | 750·4 | 753·2 | 756·0 | 758·8 | 761·5 | 764·3 | 2·8 |
| 175 | 767·1 | 769·9 | 772·6 | 775·4 | 778·1 | 780·9 | 783·7 | 786·4 | 789·2 | 791·9 | 2·8 |
| 176 | 10794·7 | 797·5 | 800·2 | 803·0 | 805·7 | 808·5 | 811·2 | 814·0 | 816·7 | 819·5 | 2·8 |
| 177 | 822·2 | 824·9 | 827·7 | 830·4 | 833·2 | 835·9 | 838·6 | 841·4 | 844·1 | 846·9 | 2·7 |
| 178 | 849·6 | 852·3 | 855·0 | 857·8 | 860·5 | 863·2 | 865·9 | 868·6 | 871·4 | 874·1 | 2·7 |
| 179 | 876·8 | 879·5 | 882·2 | 884·9 | 887·6 | 890·3 | 893·0 | 895·7 | 898·4 | 901·1 | 2·7 |
| 180 | 903·8 | 906·5 | 909·2 | 911·9 | 914·6 | 917·3 | 920·0 | 922·7 | 925·3 | 928·0 | 2·7 |
| 181 | 10930·7 | 933·4 | 936·1 | 938·7 | 941·4 | 944·1 | 946·8 | 949·5 | 952·1 | 954·8 | 2·7 |
| 182 | 957·5 | 960·2 | 962·8 | 965·5 | 968·1 | 970·8 | 973·5 | 976·1 | 978·8 | 981·4 | 2·7 |
| 183 | 984·1 | 986·8 | 989·4 | 992·1 | 994·7 | 997·4 | *000·0 | *002·7 | *005·3 | *008 0 | 2·7 |
| 184 | 11010 6 | 013·2 | 015·9 | 018·5 | 021·2 | 023·8 | 026·4 | 029·0 | 031·7 | 034·3 | 2·6 |
| 185 | 036·9 | 039·5 | 042·1 | 044·8 | 047·4 | 050·0 | 052·6 | 055·2 | 057·9 | 060·5 | 2·6 |
| 186 | 11063·1 | 065·7 | 068·3 | 070·9 | 073·5 | 076·1 | 078·7 | 081·3 | 083·9 | 086·5 | 2·6 |
| 187 | 089·1 | 091·7 | 094·3 | 096·8 | 099·4 | 102·0 | 104·6 | 107·2 | 109·7 | 112·3 | 2·6 |
| 188 | 114·9 | 117·5 | 120·1 | 122·6 | 125·2 | 127·8 | 130·4 | 132·9 | 135·5 | 138·0 | 2·6 |
| 189 | 140·6 | 143·2 | 145·7 | 148·3 | 150·8 | 153·4 | 155·9 | 158·5 | 161·0 | 163·6 | 2·6 |
| 190 | 166·1 | 168·6 | 171·2 | 173·7 | 176·3 | 178·8 | 181·3 | 183·9 | 186·4 | 189·0 | 2·5 |

## XXIII. $S_v$ for Spherical Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f.s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 191 | 11 191·5 | 194·0 | 196·5 | 199·1 | 201·6 | 204·1 | 206·6 | 209·1 | 211·7 | 214·2 | 2·5 |
| 192 | 216·7 | 219·2 | 221·7 | 224·2 | 226·7 | 229·2 | 231·7 | 234·2 | 236·7 | 239·2 | 2·5 |
| 193 | 241·7 | 244·2 | 246·7 | 249·1 | 251·6 | 254·1 | 256·6 | 259·0 | 261·5 | 263·9 | 2·5 |
| 194 | 266·4 | 268·9 | 271·4 | 273·8 | 276·3 | 278·8 | 281·3 | 283·7 | 286·2 | 288·6 | 2·5 |
| 195 | 291·1 | 293·6 | 296·0 | 298·5 | 300·9 | 303·4 | 305·9 | 308·3 | 310·8 | 313·2 | 2·5 |
| 196 | 11 315·7 | 318·1 | 320·6 | 323·0 | 325·5 | 327·9 | 330·3 | 332·8 | 335·2 | 337·7 | 2·4 |
| 197 | 340·1 | 342·5 | 344·9 | 347·4 | 349·8 | 352·2 | 354·6 | 357·0 | 359·5 | 361·9 | 2·4 |
| 198 | 364·3 | 366·7 | 369·1 | 371·5 | 373·9 | 376·3 | 378·7 | 381·1 | 383·5 | 385·9 | 2·4 |
| 199 | 388·3 | 390·7 | 393·1 | 395 5 | 397·9 | 400·3 | 402·7 | 405·1 | 407·4 | 409·8 | 2·4 |
| 200 | 412·2 | 414·6 | 417·0 | 419·3 | 421·7 | 424·1 | 426·5 | 428·8 | 431·2 | 433·5 | 2·4 |
| 201 | 11 435·9 | 438·3 | 440·7 | 443·0 | 445·4 | 447·8 | 450·2 | 452·5 | 454·9 | 457·2 | 2·4 |
| 202 | 459·6 | 461·9 | 464·3 | 466·6 | 469·0 | 471·3 | 473·7 | 476·0 | 478·4 | 480·7 | 2·3 |
| 203 | 483·1 | 485·4 | 487·8 | 490·1 | 492·5 | 494·8 | 497·1 | 499·4 | 501·8 | 504·1 | 2·3 |
| 204 | 506·4 | 508·7 | 511·0 | 513·4 | 515·7 | 518·0 | 520·3 | 522·6 | 525·0 | 527·3 | 2·3 |
| 205 | 529·6 | 531·9 | 534·2 | 536·6 | 538·9 | 541·2 | 543·5 | 545·8 | 548·2 | 550·5 | 2·3 |
| 206 | 11 552·8 | 555·1 | 557·4 | 559·7 | 562·0 | 564·3 | 566·6 | 568·9 | 571·2 | 573·5 | 2·3 |
| 207 | 575·8 | 578·1 | 580·4 | 582·6 | 584·9 | 587·2 | 589·5 | 591·8 | 594·1 | 596 4 | 2·3 |
| 208 | 598·7 | 601·0 | 603·3 | 605·5 | 607·8 | 610·1 | 612·4 | 614·7 | 616·9 | 619·2 | 2·3 |
| 209 | 621·5 | 623·8 | 626·1 | 628·3 | 630·6 | 632·9 | 635·2 | 637·5 | 639·7 | 642·0 | 2·3 |
| 210 | 644·3 | 646·6 | 648·8 | 651·1 | 653·3 | 655·6 | 657·9 | 660·1 | 662·4 | 664·6 | 2·3 |
| 211 | 11 666·9 | 669·2 | 671·4 | 673·7 | 675·9 | 678·2 | 680·5 | 682·7 | 685·0 | 687·2 | 2·3 |
| 212 | 689·5 | 691·7 | 694·0 | 696·2 | 698·5 | 700·7 | 703·0 | 705·2 | 707·5 | 709·7 | 2·2 |
| 213 | 712·0 | 714·2 | 716·5 | 718·7 | 721·0 | 723·2 | 725·4 | 727·7 | 729·9 | 732·2 | 2·2 |
| 214 | 734·4 | 736·6 | 738·8 | 741·1 | 743·3 | 745·5 | 747·7 | 750 0 | 752·2 | 754·5 | 2·2 |
| 215 | 756·7 | 758·9 | 761·1 | 763·4 | 765·6 | 767·8 | 770·0 | 772·3 | 774·5 | 776·8 | 2·2 |
| 216 | 11 779·0 | 781·2 | 783·4 | 785·7 | 787·9 | 790·1 | 792·3 | 794·5 | 796·8 | 799·0 | 2·2 |
| 217 | 801·2 | 803·4 | 805·6 | 807·8 | 810·0 | 812·2 | 814·4 | 816·6 | 818·8 | 821·0 | 2·2 |
| 218 | 823·2 | 825·4 | 827·6 | 829·8 | 832·0 | 834·2 | 836·4 | 838·6 | 840·8 | 843·0 | 2·2 |
| 219 | 845·2 | 847·4 | 849·6 | 851·8 | 854·0 | 856·2 | 858·4 | 860·6 | 862·8 | 865·0 | 2·2 |
| 220 | 867·2 | 869·4 | 871·6 | 873·7 | 875·9 | 878·1 | 880·3 | 882·5 | 884·6 | 886·8 | 2·2 |
| 221 | 11 889·0 | 891·2 | 893·4 | 895·5 | 897·7 | 899·9 | 902·1 | 904·2 | 906·4 | 908·5 | 2·2 |
| 222 | 910·7 | 912·9 | 915·1 | 917·2 | 919·4 | 921·6 | 923·8 | 926·0 | 928·1 | 930·3 | 2·2 |
| 223 | 932·5 | 934·7 | 936·8 | 939·0 | 941·1 | 943·3 | 945·5 | 947·6 | 949·8 | 951·9 | 2·2 |
| 224 | 954·1 | 956·3 | 958·4 | 960·6 | 962·7 | 964·9 | 967·0 | 969·2 | 971·3 | 973·5 | 2·2 |
| 225 | 975·6 | 977·7 | 979·9 | 982·0 | 984·2 | 986·3 | 988·5 | 990·6 | 992·8 | 994·9 | 2·1 |
| 226 | 11 997·1 | 999·2 | *001·4 | *003·5 | *005·7 | *007·8 | *009·9 | *012·1 | *014·2 | *016·4 | 2·1 |
| 227 | 12 018·5 | 020·6 | 022·7 | 024·9 | 027·0 | 029·1 | 031·2 | 033·4 | 035·5 | 037·7 | 2·1 |
| 228 | 039·8 | 041·9 | 044·0 | 046·2 | 048·3 | 050·4 | 052·5 | 054·6 | 056·8 | 058·9 | 2·1 |
| 229 | 061·0 | 063 1 | 065·2 | 067·4 | 069·5 | 071·6 | 073·7 | 075·8 | 077·9 | 080·0 | 2·1 |
| 230 | 082·1 | 084·2 | 086·3 | 088·5 | 090·6 | 092·7 | 094·8 | 096·9 | 099·1 | 101·2 | 2·1 |

## XXIV. $T_v$ for Spherical Projectiles. ($w = 534{\cdot}22$ grams).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 40 | 4·227 | 4·280 | 4·333 | 4·385 | 4·437 | 4·488 | 4·540 | 4·591 | 4·642 | 4·693 | 52 |
| 41 | 4·743 | 4·793 | 4·843 | 4·893 | 4·942 | 4·991 | 5·040 | 5·089 | 5·138 | 5·186 | 49 |
| 42 | 5·234 | 5·282 | 5·330 | 5·377 | 5·424 | 5·471 | 5·517 | 5·564 | 5·610 | 5·656 | 47 |
| 43 | 5·702 | 5·747 | 5·793 | 5·838 | 5·883 | 5·928 | 5·972 | 6·017 | 6·061 | 6·105 | 45 |
| 44 | 6·149 | 6·192 | 6·236 | 6·279 | 6·322 | 6·365 | 6·407 | 6·450 | 6·492 | 6·534 | 43 |
| 45 | 6·576 | 6·618 | 6·659 | 6·701 | 6·742 | 6·783 | 6·824 | 6·864 | 6·905 | 6·945 | 41 |
| 46 | 6·985 | 7·025 | 7·064 | 7·104 | 7·143 | 7·182 | 7·221 | 7·260 | 7·298 | 7·337 | 39 |
| 47 | 7·375 | 7·413 | 7·451 | 7·489 | 7·527 | 7·565 | 7·602 | 7·640 | 7·677 | 7·714 | 38 |
| 48 | 7·751 | 7·787 | 7·824 | 7·860 | 7 896 | 7·932 | 7·968 | 8·004 | 8·039 | 8·075 | 36 |
| 49 | 8·110 | 8·145 | 8·180 | 8·215 | 8·250 | 8·284 | 8·319 | 8·353 | 8·387 | 8·421 | 35 |
| 50 | 8·455 | 8·489 | 8·522 | 8·556 | 8·589 | 8·622 | 8·655 | 8·688 | 8·721 | 8·754 | 34 |
| 51 | 8·786 | 8·819 | 8·851 | 8·883 | 8·915 | 8·947 | 8·978 | 9·010 | 9·042 | 9·073 | 32 |
| 52 | 9·105 | 9·136 | 9·167 | 9·198 | 9·229 | 9·260 | 9·291 | 9·321 | 9·352 | 9·382 | 31 |
| 53 | 9·412 | 9·442 | 9·472 | 9·502 | 9·532 | 9·561 | 9·591 | 9·620 | 9·649 | 9·678 | 30 |
| 54 | 9·707 | 9·736 | 9·765 | 9·794 | 9·823 | 9·851 | 9·880 | 9·908 | 9·936 | 9·964 | 29 |
| 55 | 9·992 | *0·020 | *0·048 | *0·076 | *0·104 | *0·131 | *0·159 | *0·186 | *0·213 | *0·240 | 28 |
| 56 | 1 0·267 | 0·294 | 0·321 | 0·348 | 0·375 | 0·401 | 0·428 | 0·454 | 0·480 | 0·506 | 27 |
| 57 | 0·532 | 0·558 | 0·584 | 0·610 | 0·636 | 0·661 | 0·687 | 0·712 | 0·738 | 0·763 | 26 |
| 58 | 0·788 | 0·813 | 0·838 | 0·862 | 0·887 | 0·912 | 0·937 | 0·961 | 0·986 | 1·010 | 25 |
| 59 | 1·035 | 1·059 | 1·083 | 1·107 | 1·131 | 1·155 | 1·179 | 1·202 | 1·226 | 1·249 | 24 |
| 60 | 1·273 | 1·296 | 1·320 | 1·343 | 1·367 | 1·390 | 1·413 | 1·436 | 1·459 | 1·482 | 23 |
| 61 | 1 1·505 | 1·527 | 1·550 | 1·572 | 1·595 | 1·617 | 1·639 | 1·661 | 1·684 | 1·706 | 22 |
| 62 | 1·728 | 1·750 | 1·772 | 1·793 | 1·815 | 1·837 | 1·858 | 1·880 | 1·901 | 1·923 | 22 |
| 63 | 1·944 | 1·965 | 1·986 | 2·008 | 2·029 | 2·050 | 2·071 | 2·092 | 2·112 | 2·133 | 21 |
| 64 | 2·154 | 2·174 | 2·195 | 2·215 | 2·236 | 2·256 | 2·276 | 2·296 | 2·317 | 2·337 | 20 |
| 65 | 2·357 | 2·377 | 2·397 | 2·417 | 2·436 | 2·456 | 2·476 | 2·495 | 2·515 | 2·534 | 20 |
| 66 | 1 2·554 | 2·573 | 2·593 | 2·612 | 2·632 | 2·651 | 2·670 | 2·689 | 2·708 | 2·727 | 19 |
| 67 | 2·746 | 2·765 | 2·783 | 2·802 | 2·820 | 2·839 | 2·857 | 2·876 | 2·894 | 2·913 | 19 |
| 68 | 2·931 | 2·949 | 2·967 | 2·986 | 3·004 | 3·022 | 3·040 | 3·058 | 3·075 | 3·093 | 18 |
| 69 | 3·111 | 3·129 | 3·146 | 3·164 | 3·181 | 3·199 | 3·216 | 3·234 | 3·251 | 3·269 | 18 |
| 70 | 3·286 | 3·303 | 3·320 | 3·338 | 3·355 | 3·372 | 3·389 | 3·406 | 3·422 | 3·439 | 17 |
| 71 | 1 3·456 | 3·473 | 3·490 | 3·506 | 3·523 | 3·540 | 3·556 | 3·573 | 3·589 | 3·606 | 17 |
| 72 | 3·622 | 3·638 | 3·654 | 3·670 | 3·686 | 3·702 | 3·718 | 3·734 | 3·750 | 3·766 | 16 |
| 73 | 3·782 | 3·798 | 3·814 | 3·829 | 3·845 | 3·861 | 3·877 | 3·892 | 3·908 | 3·923 | 16 |
| 74 | 3·939 | 3·954 | 3·970 | 3·985 | 4·001 | 4·016 | 4·031 | 4·046 | 4·062 | 4·077 | 15 |
| 75 | 4·092 | 4·107 | 4·122 | 4·137 | 4·152 | 4·167 | 4·182 | 4·196 | 4·211 | 4·225 | 15 |
| 76 | 1 4·240 | 4·254 | 4·269 | 4·283 | 4·298 | 4·312 | 4·326 | 4·341 | 4·355 | 4·370 | 14 |
| 77 | 4·384 | 4·398 | 4·412 | 4·427 | 4·441 | 4·455 | 4·469 | 4·483 | 4·497 | 4·511 | 14 |
| 78 | 4·525 | 4·539 | 4·553 | 4·567 | 4·581 | 4·595 | 4·609 | 4·622 | 4·636 | 4·649 | 14 |
| 79 | 4·663 | 4·676 | 4·690 | 4·703 | 4·717 | 4·730 | 4·743 | 4·756 | 4·770 | 4·783 | 13 |
| 80 | 4·796 | 4·809 | 4·822 | 4·835 | 4·848 | 4·861 | 4·874 | 4·887 | 4·900 | 4·913 | 13 |
| 81 | 1 4·926 | 4·939 | 4·952 | 4·964 | 4·977 | 4·990 | 5·003 | 5·016 | 5·028 | 5·041 | 13 |
| 82 | 5·054 | 5·066 | 5·079 | 5·091 | 5·104 | 5·116 | 5·128 | 5·141 | 5·153 | 5·166 | 12 |
| 83 | 5·178 | 5·190 | 5·202 | 5·215 | 5·227 | 5·239 | 5·251 | 5·263 | 5·276 | 5·288 | 12 |
| 84 | 5·300 | 5·312 | 5·324 | 5·335 | 5·347 | 5·359 | 5·371 | 5·382 | 5·394 | 5·405 | 12 |
| 85 | 5·417 | 5·428 | 5·440 | 5·451 | 5·463 | 5·474 | 5·485 | 5·496 | 5·508 | 5·519 | 11 |

## XXIV. $T_v$ for Spherical Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 86 | 1 5·530 | 5·541 | 5·552 | 5·564 | 5·575 | 5·586 | 5·597 | 5·608 | 5·618 | 5·629 | 11 |
| 87 | 5·640 | 5·651 | 5·662 | 5·672 | 5·683 | 5·694 | 5·704 | 5·715 | 5·725 | 5·736 | 11 |
| 88 | 5·746 | 5·756 | 5·767 | 5·777 | 5·788 | 5·798 | 5·808 | 5·818 | 5·829 | 5·839 | 10 |
| 89 | 5·849 | 5·859 | 5·869 | 5·879 | 5·889 | 5·899 | 5·909 | 5·919 | 5·928 | 5·938 | 10 |
| 90 | 5·948 | 5·958 | 5·967 | 5·977 | 5·986 | 5·996 | 6·006 | 6·015 | 6·025 | 6·034 | 10 |
| 91 | 1 6·044 | 6·053 | 6·063 | 6·072 | 6·082 | 6·091 | 6·100 | 6·109 | 6·119 | 6·128 | 9 |
| 92 | 6·137 | 6·146 | 6·155 | 6·164 | 6·173 | 6·182 | 6·191 | 6·200 | 6·208 | 6·217 | 9 |
| 93 | 6·226 | 6·235 | 6·244 | 6·252 | 6·261 | 6·270 | 6·279 | 6·287 | 6·296 | 6·304 | 9 |
| 94 | 6·313 | 6·321 | 6·330 | 6·338 | 6·347 | 6·355 | 6·363 | 6·372 | 6·380 | 6·389 | 8 |
| 95 | 6·397 | 6·405 | 6·413 | 6·422 | 6·430 | 6·438 | 6·446 | 6·454 | 6·463 | 6·471 | 8 |
| 96 | 1 6·479 | 6·487 | 6·495 | 6·503 | 6·511 | 6·519 | 6·527 | 6·535 | 6·542 | 6·550 | 8 |
| 97 | 6·558 | 6·566 | 6·573 | 6·581 | 6·588 | 6·596 | 6·604 | 6·611 | 6·619 | 6·626 | 8 |
| 98 | 6·634 | 6·642 | 6·649 | 6·657 | 6·664 | 6·672 | 6·679 | 6·686 | 6·694 | 6·701 | 7 |
| 99 | 6·708 | 6·715 | 6·722 | 6·730 | 6·737 | 6·744 | 6·751 | 6·758 | 6·766 | 6·773 | 7 |
| 100 | 6·780 | 6·787 | 6·794 | 6·801 | 6·808 | 6·815 | 6·822 | 6·829 | 6·835 | 6·842 | 7 |
| 101 | 16·8491 | 8559 | 8627 | 8694 | 8761 | 8828 | 8895 | 8961 | 9027 | 9093 | 67 |
| 102 | 9158 | 9223 | 9288 | 9353 | 9417 | 9482 | 9546 | 9610 | 9673 | 9737 | 64 |
| 103 | 9800 | 9862 | 9925 | 9987 | *0049 | *0111 | *0172 | *0233 | *0294 | *0355 | 62 |
| 104 | 17·0416 | 0476 | 0536 | 0595 | 0655 | 0714 | 0773 | 0832 | 0890 | 0948 | 59 |
| 105 | 1006 | 1064 | 1121 | 1179 | 1236 | 1293 | 1350 | 1406 | 1463 | 1519 | 57 |
| 106 | 17·1575 | 1630 | 1686 | 1741 | 1796 | 1851 | 1905 | 1960 | 2014 | 2068 | 55 |
| 107 | 2122 | 2176 | 2229 | 2283 | 2336 | 2389 | 2442 | 2495 | 2547 | 2600 | 53 |
| 108 | 2652 | 2704 | 2756 | 2807 | 2859 | 2910 | 2961 | 3012 | 3062 | 3113 | 51 |
| 109 | 3163 | 3213 | 3263 | 3313 | 3363 | 3413 | 3462 | 3512 | 3561 | 3610 | 50 |
| 110 | 3659 | 3708 | 3756 | 3805 | 3853 | 3901 | 3949 | 3997 | 4044 | 4092 | 48 |
| 111 | 17·4139 | 4186 | 4233 | 4280 | 4326 | 4373 | 4419 | 4466 | 4512 | 4558 | 47 |
| 112 | 4604 | 4650 | 4696 | 4741 | 4787 | 4832 | 4877 | 4922 | 4967 | 5012 | 45 |
| 113 | 5057 | 5101 | 5145 | 5190 | 5234 | 5278 | 5322 | 5366 | 54 9 | 5453 | 44 |
| 114 | 5497 | 5540 | 5583 | 5626 | 5669 | 5712 | 5755 | 5797 | 5840 | 5882 | 43 |
| 115 | 5925 | 5967 | 6009 | 6050 | 6092 | 6134 | 6175 | 6216 | 6258 | 6299 | 42 |
| 116 | 17·6340 | 6381 | 6422 | 6462 | 6503 | 6544 | 6584 | 6625 | 6665 | 6706 | 41 |
| 117 | 6746 | 6786 | 6826 | 6865 | 6905 | 6945 | 6984 | 7023 | 7063 | 7102 | 40 |
| 118 | 7141 | 7180 | 7219 | 7257 | 7296 | 7335 | 7373 | 7412 | 7450 | 7489 | 39 |
| 119 | 7527 | 7565 | 7603 | 7640 | 7678 | 7716 | 7753 | 7791 | 7828 | 7866 | 38 |
| 120 | 7903 | 7940 | 7977 | 8014 | 8051 | 8088 | 8125 | 8161 | 8198 | 8234 | 37 |
| 121 | 17·8271 | 8307 | 8343 | 8380 | 8416 | 8452 | 8488 | 8524 | 8559 | 8595 | 36 |
| 122 | 8631 | 8666 | 8702 | 8737 | 8773 | 8808 | 8843 | 8878 | 8913 | 8948 | 35 |
| 123 | 8983 | 9018 | 9053 | 9087 | 9122 | 9157 | 9191 | 9226 | 9260 | 9295 | 35 |
| 124 | 9329 | 9363 | 9397 | 9431 | 9465 | 9499 | 9533 | 9566 | 9600 | 9633 | 34 |
| 125 | 9667 | 9700 | 9734 | 9767 | 9801 | 9834 | 9867 | 9900 | 9933 | 9966 | 33 |
| 126 | 17·9999 | *0032 | *0065 | *0097 | *0130 | *0163 | *0195 | *0228 | *0260 | *0293 | 33 |
| 127 | 18·0325 | 0357 | 0389 | 0422 | 0454 | 0486 | 0518 | 0550 | 0581 | 0613 | 32 |
| 128 | 0645 | 0677 | 0708 | 0740 | 0771 | 0803 | 0834 | 0865 | 0897 | 0928 | 31 |
| 129 | 0959 | 0990 | 1021 | 1052 | 1083 | 1114 | 1145 | 1176 | 1206 | 1237 | 31 |
| 130 | 1268 | 1298 | 1329 | 1359 | 1390 | 1420 | 1450 | 1480 | 1511 | 1541 | 30 |
| 131 | 18·1571 | 1601 | 1631 | 1661 | 1691 | 1721 | 1751 | 1780 | 1810 | 1839 | 30 |
| 132 | 1869 | 1898 | 1928 | 1957 | 1987 | 2016 | 2045 | 2074 | 2104 | 2133 | 29 |
| 133 | 2162 | 2191 | 2220 | 2248 | 2277 | 2306 | 2335 | 2363 | 2392 | 2420 | 29 |
| 134 | 2449 | 2477 | 2506 | 2534 | 2563 | 2591 | 2619 | 2647 | 2676 | 2704 | 28 |
| 135 | 2732 | 2760 | 2788 | 2815 | 2843 | 2871 | 2899 | 2926 | 2954 | 2981 | 28 |

## XXIV. $T_v$ for Spherical Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 136 | 18·3009 | 3036 | 3063 | 3091 | 3118 | 3145 | 3172 | 3199 | 3227 | 3254 | 27 |
| 137 | 3281 | 3308 | 3335 | 3361 | 3388 | 3415 | 3442 | 3469 | 3495 | 3522 | 27 |
| 138 | 3549 | 3575 | 3602 | 3628 | 3655 | 3681 | 3707 | 3733 | 3760 | 3786 | 26 |
| 139 | 3812 | 3838 | 3864 | 3890 | 3916 | 3942 | 3968 | 3994 | 4019 | 4045 | 26 |
| 140 | 4071 | 4096 | 4122 | 4147 | 4173 | 4198 | 4223 | 4249 | 4274 | 4300 | 25 |
| 141 | 18·4325 | 4350 | 4375 | 4400 | 4425 | 4450 | 4475 | 4500 | 4525 | 4550 | 25 |
| 142 | 4575 | 4600 | 4624 | 4649 | 4673 | 4698 | 4722 | 4747 | 4771 | 4796 | 25 |
| 143 | 4820 | 4844 | 4869 | 4893 | 4918 | 4942 | 4966 | 4990 | 5015 | 5039 | 24 |
| 144 | 5063 | 5087 | 5111 | 5135 | 5159 | 5183 | 5207 | 5230 | 5254 | 5277 | 24 |
| 145 | 5301 | 5325 | 5348 | 5372 | 5395 | 5419 | 5442 | 5466 | 5489 | 5513 | 24 |
| 146 | 18·5536 | 5559 | 5582 | 5606 | 5629 | 5652 | 5675 | 5698 | 5721 | 5744 | 23 |
| 147 | 5767 | 5790 | 5813 | 5835 | 5858 | 5881 | 5904 | 5926 | 5949 | 5971 | 23 |
| 148 | 5994 | 6016 | 6039 | 6061 | 6084 | 6106 | 6128 | 6151 | 6173 | 6196 | 22 |
| 149 | 6218 | 6240 | 6262 | 6285 | 6307 | 6329 | 6351 | 6373 | 6395 | 6417 | 22 |
| 150 | 6439 | 6461 | 6483 | 6504 | 6526 | 6548 | 6570 | 6591 | 6613 | 6634 | 22 |
| 151 | 18·6656 | 6677 | 6699 | 6720 | 6742 | 6763 | 6784 | 6806 | 6827 | 6849 | 21 |
| 152 | 6870 | 6891 | 6912 | 6934 | 6955 | 6976 | 6997 | 7018 | 7039 | 7060 | 21 |
| 153 | 7081 | 7102 | 7123 | 7144 | 7165 | 7186 | 7207 | 7227 | 7248 | 7268 | 21 |
| 154 | 7289 | 7310 | 7330 | 7351 | 7371 | 7392 | 7412 | 7432 | 7453 | 7474 | 21 |
| 155 | 7494 | 7514 | 7535 | 7555 | 7576 | 7596 | 7616 | 7636 | 7657 | 7677 | 20 |
| 156 | 18·7697 | 7717 | 7737 | 7757 | 7777 | 7797 | 7817 | 7837 | 7856 | 7876 | 20 |
| 157 | 7896 | 7916 | 7936 | 7955 | 7975 | 7995 | 8015 | 8034 | 8054 | 8073 | 20 |
| 158 | 8093 | 8113 | 8132 | 8152 | 8171 | 8191 | 8210 | 8230 | 8249 | 8269 | 20 |
| 159 | 8288 | 8307 | 8326 | 8346 | 8365 | 8384 | 8403 | 8422 | 8441 | 8460 | 19 |
| 160 | 8479 | 8498 | 8517 | 8536 | 8555 | 8574 | 8593 | 8612 | 8630 | 8649 | 19 |
| 161 | 18·8668 | 8687 | 8705 | 8724 | 8742 | 8761 | 8780 | 8798 | 8817 | 8835 | 19 |
| 162 | 8854 | 8873 | 8891 | 8910 | 8928 | 8947 | 8965 | 8984 | 9002 | 9021 | 19 |
| 163 | 9039 | 9057 | 9075 | 9094 | 9112 | 9130 | 9148 | 9166 | 9184 | 9202 | 18 |
| 164 | 9220 | 9238 | 9256 | 9274 | 9292 | 9310 | 9328 | 9346 | 9364 | 9382 | 18 |
| 165 | 9400 | 9418 | 9436 | 9453 | 9471 | 9489 | 9507 | 9524 | 9542 | 9559 | 18 |
| 166 | 18·9577 | 9595 | 9612 | 9630 | 9647 | 9665 | 9682 | 9700 | 9717 | 9735 | 18 |
| 167 | 9752 | 9769 | 9787 | 9804 | 9822 | 9839 | 9856 | 9873 | 9891 | 9908 | 17 |
| 168 | 9925 | 9942 | 9959 | 9977 | 9994 | *0011 | *0028 | *0045 | *0062 | *0079 | 17 |
| 169 | 19·0096 | 0113 | 0130 | 0147 | 0164 | 0181 | 0198 | 0215 | 0231 | 0248 | 17 |
| 170 | 0265 | 0282 | 0298 | 0315 | 0331 | 0348 | 0365 | 0381 | 0398 | 0414 | 17 |
| 171 | 19·0431 | 0448 | 0464 | 0481 | 0497 | 0514 | 0530 | 0547 | 0563 | 0580 | 17 |
| 172 | 0596 | 0612 | 0629 | 0645 | 0662 | 0678 | 0694 | 0710 | 0727 | 0743 | 16 |
| 173 | 0759 | 0775 | 0791 | 0808 | 0824 | 0840 | 0856 | 0872 | 0888 | 0904 | 16 |
| 174 | 0920 | 0936 | 0952 | 0968 | 0984 | 1000 | 1016 | 1032 | 1048 | 1064 | 16 |
| 175 | 1080 | 1096 | 1112 | 1127 | 1143 | 1159 | 1175 | 1190 | 1206 | 1221 | 16 |
| 176 | 19·1237 | 1253 | 1268 | 1284 | 1299 | 1315 | 1331 | 1346 | 1362 | 1377 | 16 |
| 177 | 1393 | 1408 | 1424 | 1439 | 1455 | 1470 | 1485 | 1501 | 1516 | 1532 | 15 |
| 178 | 1547 | 1562 | 1577 | 1593 | 1608 | 1623 | 1638 | 1653 | 1669 | 1684 | 15 |
| 179 | 1699 | 1714 | 1729 | 1745 | 1760 | 1775 | 1790 | 1805 | 1820 | 1835 | 15 |
| 180 | 1850 | 1865 | 1880 | 1895 | 1910 | 1925 | 1940 | 1955 | 1969 | 1984 | 15 |
| 181 | 19·1999 | 2014 | 2029 | 2043 | 2058 | 2073 | 2088 | 2103 | 2117 | 2132 | 15 |
| 182 | 2147 | 2162 | 2176 | 2191 | 2205 | 2220 | 2235 | 2249 | 2264 | 2278 | 15 |
| 183 | 2293 | 2307 | 2322 | 2336 | 2351 | 2365 | 2379 | 2394 | 2408 | 2423 | 14 |
| 184 | 2437 | 2451 | 2466 | 2480 | 2495 | 2509 | 2523 | 2537 | 2552 | 2566 | 14 |
| 185 | 2580 | 2594 | 2608 | 2622 | 2636 | 2650 | 2664 | 2678 | 2693 | 2707 | 14 |

## XXIV. $T_v$ for Spherical Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 186 | 19·2721 | 2735 | 2749 | 2763 | 2777 | 2791 | 2805 | 2819 | 2832 | 2846 | 14 |
| 187 | 2860 | 2874 | 2888 | 2901 | 2915 | 2929 | 2943 | 2957 | 2970 | 2984 | 14 |
| 188 | 2998 | 3012 | 3025 | 3039 | 3052 | 3066 | 3080 | 3093 | 3107 | 3120 | 14 |
| 189 | 3134 | 3148 | 3161 | 3175 | 3188 | 3202 | 3215 | 3229 | 3242 | 3256 | 14 |
| 190 | 3269 | 3282 | 3296 | 3309 | 3323 | 3336 | 3349 | 3362 | 3376 | 3389 | 13 |
| 191 | 19·3402 | 3415 | 3428 | 3442 | 3455 | 3468 | 3481 | 3494 | 3508 | 3521 | 13 |
| 192 | 3534 | 3547 | 3560 | 3573 | 3586 | 3599 | 3612 | 3625 | 3638 | 3651 | 13 |
| 193 | 3664 | 3677 | 3690 | 3702 | 3715 | 3728 | 3741 | 3754 | 3766 | 3779 | 13 |
| 194 | 3792 | 3805 | 3817 | 3830 | 3842 | 3855 | 3868 | 3880 | 3893 | 3905 | 13 |
| 195 | 3918 | 3931 | 3943 | 3956 | 3968 | 3981 | 3994 | 4006 | 4019 | 4031 | 13 |
| 196 | 19·4044 | 4056 | 4068 | 4081 | 4094 | 4106 | 4118 | 4131 | 4143 | 4156 | 12 |
| 197 | 4168 | 4180 | 4192 | 4205 | 4217 | 4229 | 4241 | 4253 | 4266 | 4278 | 12 |
| 198 | 4290 | 4302 | 4314 | 4327 | 4339 | 4351 | 4363 | 4375 | 4388 | 4400 | 12 |
| 199 | 4412 | 4424 | 4436 | 4448 | 4460 | 4472 | 4484 | 4496 | 4508 | 4520 | 12 |
| 200 | 4532 | 4544 | 4556 | 4567 | 4579 | 4591 | 4603 | 4615 | 4626 | 4638 | 12 |
| 201 | 19·4650 | 4662 | 4674 | 4685 | 4697 | 4709 | 4721 | 4732 | 4744 | 4755 | 12 |
| 202 | 4767 | 4779 | 4790 | 4802 | 4813 | 4825 | 4837 | 4848 | 4860 | 4871 | 12 |
| 203 | 4883 | 4895 | 4906 | 4918 | 4929 | 4941 | 4952 | 4964 | 4975 | 4987 | 12 |
| 204 | 4998 | 5009 | 5021 | 5032 | 5044 | 5055 | 5066 | 5078 | 5089 | 5101 | 11 |
| 205 | 5112 | 5123 | 5134 | 5146 | 5157 | 5168 | 5179 | 5190 | 5202 | 5213 | 11 |
| 206 | 19·5224 | 5235 | 5246 | 5258 | 5269 | 5280 | 5291 | 5302 | 5314 | 5325 | 11 |
| 207 | 5336 | 5347 | 5358 | 5369 | 5380 | 5391 | 5402 | 5413 | 5424 | 5435 | 11 |
| 208 | 5446 | 5457 | 5468 | 5479 | 5490 | 5501 | 5512 | 5523 | 5534 | 5545 | 11 |
| 209 | 5556 | 5567 | 5578 | 5588 | 5599 | 5610 | 5621 | 5632 | 5642 | 5653 | 11 |
| 210 | 5664 | 5675 | 5686 | 5696 | 5707 | 5718 | 5729 | 5740 | 5750 | 5761 | 11 |
| 211 | 19·5772 | 5783 | 5793 | 5804 | 5814 | 5825 | 5836 | 5846 | 5857 | 5867 | 11 |
| 212 | 5878 | 5889 | 5899 | 5910 | 5920 | 5931 | 5942 | 5952 | 5963 | 5973 | 11 |
| 213 | 5984 | 5995 | 6005 | 6016 | 6026 | 6037 | 6047 | 6058 | 6068 | 6079 | 11 |
| 214 | 6089 | 6099 | 6110 | 6120 | 6131 | 6141 | 6151 | 6162 | 6172 | 6183 | 10 |
| 215 | 6193 | 6203 | 6214 | 6224 | 6235 | 6245 | 6255 | 6266 | 6276 | 6287 | 10 |
| 216 | 19·6297 | 6307 | 6317 | 6328 | 6338 | 6348 | 6358 | 6368 | 6379 | 6389 | 10 |
| 217 | 6399 | 6409 | 6419 | 6430 | 6440 | 6450 | 6460 | 6470 | 6481 | 6491 | 10 |
| 218 | 6501 | 6511 | 6521 | 6531 | 6541 | 6551 | 6561 | 6571 | 6581 | 6591 | 10 |
| 219 | 6601 | 6611 | 6621 | 6631 | 6641 | 6651 | 6661 | 6671 | 6681 | 6691 | 10 |
| 220 | 6701 | 6711 | 6721 | 6731 | 6741 | 6751 | 6761 | 6771 | 6781 | 6791 | 10 |
| 221 | 19·6801 | 6811 | 6821 | 6830 | 6840 | 6850 | 6860 | 6869 | 6879 | 6888 | 10 |
| 222 | 6898 | 6908 | 6918 | 6927 | 6937 | 6947 | 6957 | 6967 | 6976 | 6986 | 10 |
| 223 | 6996 | 7006 | 7016 | 7025 | 7035 | 7045 | 7055 | 7064 | 7074 | 7083 | 10 |
| 224 | 7093 | 7103 | 7112 | 7122 | 7131 | 7141 | 7151 | 7160 | 7170 | 7179 | 10 |
| 225 | 7189 | 7198 | 7208 | 7217 | 7227 | 7236 | 7246 | 7255 | 7265 | 7274 | 9 |
| 226 | 19·7284 | 7293 | 7303 | 7312 | 7322 | 7331 | 7340 | 7350 | 7359 | 7369 | 9 |
| 227 | 7378 | 7387 | 7397 | 7406 | 7416 | 7425 | 7434 | 7444 | 7453 | 7463 | 9 |
| 228 | 7472 | 7481 | 7491 | 7500 | 7510 | 7519 | 7528 | 7537 | 7547 | 7556 | 9 |
| 229 | 7565 | 7574 | 7583 | 7593 | 7602 | 7611 | 7620 | 7629 | 7639 | 7648 | 9 |

## XXV. $S_v$ for Ogival-headed Projectiles. ($w = 534{\cdot}22$ grains.)

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 10 | 935 | 1099 | 1262 | 1423 | 1583 | 1741 | 1898 | 2053 | 2207 | 2359 | 158 |
| 11 | 2510 | 2660 | 2808 | 2955 | 3101 | 3245 | 3388 | 3530 | 3671 | 3811 | 145 |
| 12 | 3949 | 4086 | 4222 | 4357 | 4491 | 4624 | 4756 | 4886 | 5016 | 5144 | 133 |
| 13 | 5272 | 5399 | 5525 | 5649 | 5773 | 5896 | 6018 | 6139 | 6259 | 6378 | 123 |
| 14 | 6497 | 6614 | 6731 | 6847 | 6962 | 7077 | 7190 | 7303 | 7415 | 7526 | 114 |
| 15 | 7637 | 7747 | 7856 | 7964 | 8072 | 8179 | 8285 | 8391 | 8496 | 8600 | 107 |
| 16 | 8704 | 8807 | 8910 | 9012 | 9113 | 9213 | 9313 | 9412 | 9511 | 9609 | 101 |
| 17 | 9706 | 9803 | 9900 | 9996 | *0091 | *0185 | *0279 | *0373 | *0466 | *0559 | 95 |
| 18 | 1 0651 | 0742 | 0833 | 0924 | 1014 | 1104 | 1193 | 1281 | 1369 | 1457 | 90 |
| 19 | 1 1544 | 1631 | 1717 | 1803 | 1888 | 1973 | 2058 | 2142 | 2226 | 2309 | 85 |
| 20 | 2392 | 2474 | 2556 | 2638 | 2719 | 2800 | 2881 | 2961 | 3041 | 3120 | 81 |
| 21 | 3199 | 3278 | 3356 | 3434 | 3511 | 3588 | 3665 | 3741 | 3817 | 3892 | 77 |
| 22 | 1 3967 | 4042 | 4117 | 4191 | 4265 | 4338 | 4411 | 4484 | 4557 | 4630 | 74 |
| 23 | 4702 | 4774 | 4845 | 4916 | 4987 | 5058 | 5128 | 5198 | 5268 | 5337 | 71 |
| 24 | 5406 | 5475 | 5544 | 5612 | 5680 | 5747 | 5814 | 5881 | 5948 | 6014 | 68 |
| 25 | 1 6080 | 6146 | 6212 | 6277 | 6342 | 6407 | 6472 | 6537 | 6601 | 6665 | 65 |
| 26 | 6729 | 6793 | 6856 | 6919 | 6982 | 7044 | 7106 | 7168 | 7230 | 7291 | 62 |
| 27 | 7352 | 7413 | 7474 | 7535 | 7595 | 7655 | 7715 | 7775 | 7835 | 7895 | 60 |
| 28 | 1 7954 | 8013 | 8072 | 8131 | 8189 | 8247 | 8305 | 8363 | 8420 | 8477 | 58 |
| 29 | 8534 | 8591 | 8648 | 8704 | 8760 | 8816 | 8872 | 8928 | 8984 | 9039 | 56 |
| 30 | 9094 | 9149 | 9204 | 9259 | 9313 | 9367 | 9421 | 9475 | 9529 | 9583 | 54 |
| 31 | 1 9636 | 9689 | 9742 | 9795 | 9848 | 9901 | 9953 | *0005 | *0057 | *0109 | 53 |
| 32 | 2 0161 | 0213 | 0264 | 0315 | 0366 | 0417 | 0468 | 0519 | 0569 | 0619 | 51 |
| 33 | 0669 | 0719 | 0769 | 0819 | 0869 | 0918 | 0967 | 1016 | 1065 | 1114 | 50 |
| 34 | 2 1163 | 1212 | 1260 | 1308 | 1356 | 1404 | 1452 | 1500 | 1548 | 1595 | 48 |
| 35 | 1642 | 1689 | 1736 | 1783 | 1830 | 1876 | 1923 | 1969 | 2015 | 2061 | 47 |
| 36 | 2107 | 2153 | 2199 | 2245 | 2290 | 2335 | 2380 | 2425 | 2470 | 2515 | 45 |
| 37 | 2 2560 | 2605 | 2650 | 2694 | 2738 | 2782 | 2826 | 2870 | 2914 | 2958 | 44 |
| 38 | 3001 | 3045 | 3088 | 3131 | 3174 | 3217 | 3260 | 3303 | 3346 | 3388 | 43 |
| 39 | 3430 | 3473 | 3515 | 3557 | 3599 | 3641 | 3683 | 3725 | 3767 | 3808 | 42 |
| 40 | 2 3849 | 3890 | 3931 | 3972 | 4013 | 4054 | 4095 | 4136 | 4177 | 4217 | 41 |
| 41 | 4257 | 4297 | 4337 | 4377 | 4417 | 4457 | 4497 | 4537 | 4577 | 4616 | 40 |
| 42 | 4655 | 4695 | 4734 | 4773 | 4812 | 4851 | 4890 | 4929 | 4968 | 5006 | 39 |
| 43 | 2 5044 | 5083 | 5121 | 5159 | 5197 | 5235 | 5273 | 5311 | 5349 | 5387 | 38 |
| 44 | 5424 | 5462 | 5499 | 5537 | 5574 | 5611 | 5648 | 5685 | 5722 | 5759 | 37 |
| 45 | 5796 | 5833 | 5869 | 5906 | 5942 | 5979 | 6015 | 6051 | 6087 | 6123 | 36 |
| 46 | 2 6159 | 6195 | 6230 | 6266 | 6301 | 6337 | 6372 | 6408 | 6443 | 6479 | 36 |
| 47 | 6514 | 6549 | 6584 | 6618 | 6653 | 6688 | 6723 | 6758 | 6792 | 6827 | 35 |
| 48 | 6862 | 6896 | 6930 | 6965 | 6999 | 7033 | 7067 | 7101 | 7135 | 7169 | 34 |
| 49 | 2 7203 | 7237 | 7270 | 7304 | 7337 | 7371 | 7404 | 7437 | 7471 | 7504 | 33 |
| 50 | 7537 | 7570 | 7603 | 7635 | 7668 | 7701 | 7734 | 7766 | 7799 | 7831 | 33 |
| 51 | 7864 | 7896 | 7928 | 7961 | 7993 | 8025 | 8057 | 8089 | 8121 | 8153 | 32 |
| 52 | 2 8185 | 8217 | 8248 | 8280 | 8311 | 8343 | 8374 | 8406 | 8437 | 8469 | 32 |
| 53 | 8500 | 8531 | 8562 | 8593 | 8624 | 8655 | 8686 | 8717 | 8747 | 8778 | 31 |
| 54 | 8809 | 8839 | 8870 | 8900 | 8931 | 8961 | 8991 | 9021 | 9052 | 9082 | 30 |
| 55 | 2 9112 | 9142 | 9172 | 9202 | 9232 | 9262 | 9292 | 9321 | 9351 | 9380 | 30 |
| 56 | 9410 | 9439 | 9469 | 9498 | 9528 | 9557 | 9586 | 9615 | 9645 | 9674 | 29 |
| 57 | 9703 | 9732 | 9761 | 9789 | 9818 | 9847 | 9876 | 9904 | 9933 | 9961 | 29 |

## XXV. $S_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 58 | 2 9990 | *0018 | *0047 | *0075 | *0104 | *0132 | *0160 | *0188 | *0217 | *0245 | 28 |
| 59 | 3 0273 | 0301 | 0329 | 0357 | 0385 | 0413 | 0441 | 0468 | 0496 | 0523 | 28 |
| 60 | 0551 | 0578 | 0606 | 0633 | 0661 | 0688 | 0715 | 0742 | 0770 | 0797 | 27 |
| 61 | 3 0824 | 0851 | 0878 | 0905 | 0932 | 0959 | 0986 | 1013 | 1039 | 1066 | 27 |
| 62 | 1093 | 1120 | 1146 | 1173 | 1199 | 1226 | 1252 | 1278 | 1305 | 1331 | 26 |
| 63 | 1357 | 1383 | 1409 | 1436 | 1462 | 1488 | 1514 | 1540 | 1566 | 1592 | 26 |
| 64 | 3 1618 | 1644 | 1670 | 1695 | 1721 | 1747 | 1772 | 1798 | 1823 | 1849 | 26 |
| 65 | 1874 | 1899 | 1925 | 1950 | 1976 | 2001 | 2026 | 2051 | 2076 | 2101 | 25 |
| 66 | 2126 | 2151 | 2176 | 2201 | 2226 | 2251 | 2276 | 2301 | 2325 | 2350 | 25 |
| 67 | 3 2375 | 2400 | 2424 | 2449 | 2473 | 2498 | 2522 | 2547 | 2571 | 2596 | 25 |
| 68 | 2620 | 2644 | 2668 | 2693 | 2717 | 2741 | 2765 | 2789 | 2813 | 2837 | 24 |
| 69 | 2861 | 2885 | 2909 | 2932 | 2956 | 2980 | 3004 | 3028 | 3051 | 3075 | 24 |
| 70 | 3 3099 | 3123 | 3146 | 3170 | 3193 | 3217 | 3240 | 3263 | 3287 | 3310 | 23 |
| 71 | 3333 | 3356 | 3379 | 3403 | 3426 | 3449 | 3472 | 3495 | 3518 | 3541 | 23 |
| 72 | 3564 | 3587 | 3610 | 3632 | 3655 | 3678 | 3701 | 3724 | 3746 | 3769 | 23 |
| 73 | 3 3792 | 3815 | 3837 | 3860 | 3882 | 3905 | 3927 | 3950 | 3972 | 3995 | 23 |
| 74 | 4017 | 4039 | 4061 | 4084 | 4106 | 4128 | 4150 | 4172 | 4195 | 4217 | 22 |
| 75 | 4239 | 4261 | 4283 | 4305 | 4327 | 4349 | 4371 | 4393 | 4414 | 4436 | 22 |
| 76 | 3 4458 | 4480 | 4501 | 4523 | 4544 | 4566 | 4588 | 4609 | 4631 | 4652 | 22 |
| 77 | 4674 | 4695 | 4717 | 4738 | 4760 | 4781 | 4802 | 4823 | 4845 | 4866 | 21 |
| 78 | 4887 | 4908 | 4929 | 4951 | 4972 | 4993 | 5014 | 5035 | 5056 | 5077 | 21 |
| 79 | 3 5098 | 5119 | 5140 | 5161 | 5182 | 5202 | 5223 | 5244 | 5265 | 5285 | 21 |
| 80 | 5306 | 5327 | 5347 | 5368 | 5389 | 5409 | 5430 | 5450 | 5471 | 5491 | 20 |
| 81 | 5512 | 5532 | 5552 | 5573 | 5593 | 5613 | 5634 | 5654 | 5674 | 5694 | 20 |
| 82 | 3 5714 | 5734 | 5754 | 5775 | 5795 | 5815 | 5834 | 5854 | 5874 | 5894 | 20 |
| 83 | 5914 | 5933 | 5953 | 5973 | 5992 | 6012 | 6031 | 6051 | 6070 | 6089 | 19 |
| 84 | 6109 | 6128 | 6147 | 6166 | 6185 | 6204 | 6223 | 6242 | 6261 | 6280 | 19 |
| 85 | 3 6299 | 6318 | 6336 | 6355 | 6374 | 6393 | 6411 | 6430 | 6448 | 6467 | 19 |
| 86 | 6485 | 6503 | 6522 | 6540 | 6558 | 6576 | 6594 | 6612 | 6630 | 6648 | 18 |
| 87 | 6666 | 6684 | 6702 | 6720 | 6738 | 6756 | 6773 | 6791 | 6809 | 6826 | 18 |
| 88 | 3 6844 | 6861 | 6879 | 6896 | 6914 | 6931 | 6948 | 6966 | 6983 | 7000 | 17 |
| 89 | 7017 | 7034 | 7052 | 7069 | 7086 | 7103 | 7120 | 7136 | 7153 | 7170 | 17 |
| 90 | 7187 | 7204 | 7220 | 7237 | 7254 | 7271 | 7287 | 7303 | 7320 | 7336 | 17 |
| 91 | 3 7353 | 7369 | 7386 | 7402 | 7418 | 7435 | 7451 | 7467 | 7483 | 7499 | 16 |
| 92 | 7515 | 7531 | 7547 | 7563 | 7579 | 7595 | 7611 | 7627 | 7643 | 7658 | 16 |
| 93 | 7674 | 7690 | 7705 | 7721 | 7737 | 7752 | 7768 | 7783 | 7798 | 7814 | 16 |
| 94 | 3 7829 | 7845 | 7860 | 7875 | 7891 | 7906 | 7921 | 7936 | 7951 | 7966 | 15 |
| 95 | 7982 | 7997 | 8012 | 8027 | 8042 | 8057 | 8071 | 8086 | 8101 | 8116 | 15 |
| 96 | 8131 | 8145 | 8160 | 8175 | 8189 | 8204 | 8218 | 8233 | 8247 | 8262 | 15 |
| 97 | 3 8277 | 8291 | 8305 | 8320 | 8334 | 8348 | 8363 | 8377 | 8391 | 8405 | 14 |
| 98 | 8419 | 8433 | 8448 | 8462 | 8476 | 8490 | 8504 | 8518 | 8532 | 8546 | 14 |
| 99 | 8560 | 8573 | 8587 | 8601 | 8615 | 8628 | 8642 | 8656 | 8669 | 8683 | 14 |
| 100 | 3 8697 | 8710 | 8724 | 8737 | 8751 | 8764 | 8778 | 8791 | 8804 | 8818 | 13 |
| 101 | 8831 | 8844 | 8857 | 8871 | 8884 | 8897 | 8910 | 8923 | 8936 | 8949 | 13 |
| 102 | 8962 | 8975 | 8988 | 9000 | 9013 | 9026 | 9038 | 9051 | 9063 | 9076 | 13 |
| 103 | 3 9088 | 9100 | 9113 | 9125 | 9137 | 9149 | 9161 | 9172 | 9184 | 9196 | 12 |
| 104 | 9207 | 9219 | 9230 | 9241 | 9252 | 9263 | 9274 | 9285 | 9295 | 9306 | 11 |
| 105 | 9317 | 9327 | 9337 | 9347 | 9357 | 9367 | 9377 | 9387 | 9396 | 9406 | 10 |

## XXV. $S_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 106 | 39415·7 | 425·0 | 434·2 | 443·5 | 452·7 | 462·0 | 471·0 | 479·9 | 488·9 | 497·8 | 9·1 |
| 107 | 506·8 | 515·5 | 524·3 | 533·0 | 541·8 | 550·5 | 559·0 | 567·5 | 576·0 | 584·5 | 8·6 |
| 108 | 593·0 | 601·2 | 609·5 | 617·7 | 626·0 | 634·3 | 642·4 | 650·5 | 658·6 | 666·7 | 8·2 |
| 109 | 39674·8 | 682·8 | 690·7 | 698·6 | 706·5 | 714·4 | 722·2 | 730·0 | 737·8 | 745·6 | 7·9 |
| 110 | 753·4 | 761·1 | 768·8 | 776·5 | 784·2 | 791·9 | 799·5 | 807·1 | 814·6 | 822·2 | 7·6 |
| 111 | 829·7 | 837·1 | 844·5 | 851·9 | 859·3 | 866·8 | 874·1 | 881·4 | 888·8 | 896·1 | 7·4 |
| 112 | 39903·5 | 910·7 | 918·0 | 925·2 | 932·5 | 939·8 | 946·9 | 954·1 | 961·3 | 968·5 | 7·2 |
| 113 | 975·7 | 982·8 | 989·9 | 997·0 | *004·1 | *011·2 | *018·2 | *025·2 | *032·3 | *039·3 | 7·1 |
| 114 | 40046·4 | 053·4 | 060·4 | 067·4 | 074·4 | 081·4 | 088·3 | 095·2 | 102·2 | 109·1 | 7·0 |
| 115 | 40116·1 | 122·9 | 129·8 | 136·6 | 143·5 | 150·4 | 157·2 | 164·0 | 170·8 | 177·6 | 6·8 |
| 116 | 184·4 | 191·1 | 197·9 | 204·6 | 211·4 | 218·2 | 224·9 | 231·6 | 238·3 | 245·0 | 6·7 |
| 117 | 251·7 | 258·3 | 265·0 | 271·6 | 278·2 | 284·9 | 291·5 | 298·0 | 304·6 | 311·2 | 6·6 |
| 118 | 40317·8 | 324·3 | 330·8 | 337·3 | 343·9 | 350·4 | 356·8 | 363·3 | 369·8 | 376·2 | 6·5 |
| 119 | 382·7 | 389·1 | 395·5 | 401·9 | 408·4 | 414·8 | 421·1 | 427·5 | 433·9 | 440·2 | 6·4 |
| 120 | 446·6 | 452·9 | 459·2 | 465·5 | 471·9 | 478·2 | 484·4 | 490·7 | 497·0 | 503·2 | 6·3 |
| 121 | 40509·5 | 515·7 | 521·9 | 528·1 | 534·3 | 540·5 | 546·6 | 552·8 | 559·0 | 565·1 | 6·2 |
| 122 | 571·3 | 577·4 | 583·5 | 589·6 | 595·7 | 601·8 | 607·8 | 613·9 | 620·0 | 626·0 | 6·1 |
| 123 | 632·1 | 638·1 | 644·1 | 650·1 | 656·1 | 662·1 | 668 0 | 674·0 | 680·0 | 685·9 | 6·0 |
| 124 | 40691·9 | 697·8 | 703·7 | 709·6 | 715·6 | 721·5 | 727·3 | 733·2 | 739·1 | 744·9 | 5·9 |
| 125 | 750·8 | 756·6 | 762·4 | 768·2 | 774·0 | 779·8 | 785·5 | 791·3 | 797·1 | 802·8 | 5·8 |
| 126 | 808·6 | 814·3 | 820·1 | 825·8 | 831·5 | 837·3 | 843·0 | 848·7 | 854·4 | 860·1 | 5·7 |
| 127 | 40865·8 | 871·4 | 877·0 | 882·6 | 888·3 | 893·9 | 899·5 | 905·1 | 910·7 | 916·3 | 5·6 |
| 128 | 921·9 | 927·4 | 933·0 | 938·5 | 944·0 | 949·6 | 955·1 | 960·6 | 966·1 | 971·6 | 5·5 |
| 129 | 977·1 | 982·5 | 988·0 | 993·5 | 998·9 | *004·4 | *009·8 | *015·2 | *020·6 | *026·1 | 5·4 |
| 130 | 41031·5 | 036·9 | 042·3 | 047·7 | 053·1 | 058·5 | 063·8 | 069·2 | 074·6 | 079·9 | 5·4 |
| 131 | 085·3 | 090·6 | 095·9 | 101·2 | 106·6 | 111·9 | 117·2 | 122·5 | 127·8 | 133·1 | 5·3 |
| 132 | 138 4 | 143·6 | 148·9 | 154·2 | 159·4 | 164·7 | 169·9 | 175·1 | 180·3 | 185·6 | 5·2 |
| 133 | 41190·8 | 196·0 | 201·2 | 206·4 | 211·6 | 216·8 | 221·9 | 227·1 | 232·3 | 237·4 | 5·2 |
| 134 | 242·6 | 247·7 | 252·9 | 258·0 | 263·1 | 268·3 | 273·4 | 278·5 | 283·6 | 288·8 | 5·1 |
| 135 | 293·9 | 298·9 | 304·0 | 309·1 | 314·1 | 319·2 | 324·2 | 329·3 | 334·4 | 339·4 | 5·1 |
| 136 | 41344·5 | 349·5 | 354·6 | 359·6 | 364·6 | 369·7 | 374·7 | 379·7 | 384·7 | 389·7 | 5·0 |
| 137 | 394·7 | 399·7 | 404·6 | 409·6 | 414·6 | 419·6 | 424·5 | 429·5 | 434·5 | 439·4 | 5·0 |
| 138 | 444·4 | 449·3 | 454·2 | 459·1 | 464·1 | 469·0 | 473·9 | 478·8 | 483·7 | 488·6 | 4·9 |
| 139 | 41493·5 | 498·4 | 503·2 | 508·1 | 513·0 | 517·9 | 522·7 | 527·6 | 532·5 | 537·3 | 4·9 |
| 140 | 542·2 | 547·0 | 551·9 | 556·7 | 561·5 | 566·4 | 571·2 | 576·0 | 580·8 | 585·7 | 4·8 |
| 141 | 590·5 | 595·3 | 600·1 | 604·9 | 609·7 | 614·5 | 619·3 | 624·0 | 628·8 | 633·6 | 4·8 |
| 142 | 41638·4 | 643·1 | 647·9 | 652·6 | 657·3 | 662·1 | 666·8 | 671·6 | 676·3 | 681·0 | 4·7 |
| 143 | 685·8 | 690·5 | 695·2 | 699·9 | 704·7 | 709·4 | 714·1 | 718·8 | 723·5 | 728·2 | 4·7 |
| 144 | 732·9 | 737·6 | 742·2 | 746·9 | 751·6 | 756·3 | 760·9 | 765·6 | 770·3 | 774·9 | 4·7 |
| 145 | 41779·6 | 784·2 | 788·9 | 793·6 | 798·2 | 802·9 | 807·5 | 812·2 | 816·8 | 821·4 | 4·6 |
| 146 | 826·1 | 830·7 | 835·3 | 839·9 | 844·6 | 849·2 | 853·8 | 858·4 | 863·0 | 867·6 | 4·6 |
| 147 | 872·2 | 876·8 | 881·4 | 886·0 | 890·6 | 895·2 | 899·8 | 904·4 | 908·9 | 913·5 | 4·6 |
| 148 | 41918·1 | 922·7 | 927·2 | 931·8 | 936·3 | 940·9 | 945·4 | 950·0 | 954·5 | 959·1 | 4·6 |
| 149 | 963·6 | 968·1 | 972·7 | 977·2 | 981·8 | 986·3 | 990·8 | 995·3 | 999·9 | *004·4 | 4·5 |
| 150 | 42008·9 | 013·4 | 017·9 | 022·5 | 027·0 | 031·5 | 036·0 | 040·5 | 044·9 | 049·4 | 4·5 |
| 151 | 42053·9 | 058·4 | 062·9 | 067·3 | 071·8 | 076·3 | 080·8 | 085·3 | 089·7 | 094·2 | 4·5 |
| 152 | 098·7 | 103·2 | 107·6 | 112·1 | 116·5 | 121·0 | 125·4 | 129·8 | 134·3 | 138·7 | 4·4 |
| 153 | 143·1 | 147·5 | 151·9 | 156·4 | 160·8 | 165·2 | 169·6 | 174·1 | 178·5 | 183·0 | 4·4 |

## XXV. $S_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 154 | 42 187·4 | 191·8 | 196·3 | 200·7 | 205·2 | 209·6 | 214·0 | 218·4 | 222·9 | 227·3 | 4·4 |
| 155 | 231·7 | 236·1 | 240·5 | 245·0 | 249·4 | 253·8 | 258·2 | 262·6 | 266·9 | 271·3 | 4·4 |
| 156 | 275·7 | 280·1 | 284·5 | 288·8 | 293·2 | 297·6 | 302·0 | 306·4 | 310·7 | 315·1 | 4·4 |
| 157 | 42 319·5 | 323·9 | 328·2 | 332·6 | 336·9 | 341·3 | 345·7 | 350·0 | 354·4 | 358·7 | 4·4 |
| 158 | 363·1 | 367·4 | 371·8 | 376·1 | 380·5 | 384·8 | 389·1 | 393·5 | 397·8 | 402·2 | 4·3 |
| 159 | 406·5 | 410·8 | 415·1 | 419·5 | 423·8 | 428·1 | 432·4 | 436·7 | 441·1 | 445·4 | 4·3 |
| 160 | 42 449·7 | 454·0 | 458·3 | 462·6 | 466·9 | 471·2 | 475·5 | 479·8 | 484·1 | 488·4 | 4·3 |
| 161 | 492·7 | 497·0 | 501·3 | 505·6 | 509·9 | 514·2 | 518·5 | 522·8 | 527·0 | 531·3 | 4·3 |
| 162 | 535·6 | 539·9 | 544·2 | 548·4 | 552·7 | 557·0 | 561·3 | 565·5 | 569·8 | 574·0 | 4·3 |
| 163 | 42 578·3 | 582·5 | 586·8 | 591·0 | 595·3 | 599·5 | 603·7 | 608·0 | 612·2 | 616·5 | 4·2 |
| 164 | 620·7 | 624·9 | 629·2 | 633·4 | 637·7 | 641·9 | 646·1 | 650·3 | 654·6 | 658·8 | 4·2 |
| 165 | 663·0 | 667·2 | 671·4 | 675·7 | 679·9 | 684·1 | 688·3 | 692·5 | 696·8 | 701·0 | 4·2 |
| 166 | 42 705·2 | 709·4 | 713·6 | 717·8 | 722·0 | 726·2 | 730·4 | 734·6 | 738·8 | 743·0 | 4·2 |
| 167 | 747 2 | 751·4 | 755·6 | 759·7 | 763·9 | 768·1 | 772·3 | 776·5 | 780·6 | 784·8 | 4·2 |
| 168 | 789·0 | 793·2 | 797·3 | 801·5 | 805·6 | 809·8 | 814·0 | 818·1 | 822·3 | 826·4 | 4·2 |
| 169 | 42 830·6 | 834·8 | 838·9 | 843·1 | 847·2 | 851·4 | 855·5 | 859·7 | 863·8 | 868·0 | 4·2 |
| 170 | 872·1 | 876·2 | 880·4 | 884·5 | 888·7 | 892·8 | 896·9 | 901·1 | 905·2 | 909·4 | 4·1 |
| 171 | 913·5 | 917·6 | 921·7 | 925·9 | 930 0 | 934·1 | 938·2 | 942·3 | 946·5 | 950·6 | 4·1 |
| 172 | 42 954·7 | 958·8 | 962·9 | 967·1 | 971·2 | 975·3 | 979·4 | 983·5 | 987·6 | 991·7 | 4·1 |
| 173 | 995·8 | 999·9 | *004·0 | *008·1 | *012·2 | *016·3 | *020·4 | *024·5 | *028·5 | *032·6 | 4·1 |
| 174 | 43 036·7 | 040·8 | 044·9 | 048·9 | 053·0 | 057·1 | 061·2 | 065·3 | 069·3 | 073·4 | 4·1 |
| 175 | 43 077·5 | 081 6 | 085·6 | 089·7 | 093·7 | 097·8 | 101·9 | 105·9 | 110·0 | 114·1 | 4·1 |
| 176 | 118·1 | 122·1 | 126·2 | 130·2 | 134·3 | 138·3 | 142·3 | 146·4 | 150·4 | 154·5 | 4·0 |
| 177 | 158·5 | 162·5 | 166·5 | 170·6 | 174·6 | 178·6 | 182·6 | 186·6 | 190·7 | 194·7 | 4·0 |
| 178 | 43 198·7 | 202·7 | 206·7 | 210·7 | 214·7 | 218·7 | 222·7 | 226·7 | 230·8 | 234·8 | 4·0 |
| 179 | 238·8 | 242·8 | 246·8 | 250·8 | 254·8 | 258·8 | 262·8 | 266·8 | 270·7 | 274·7 | 4·0 |
| 180 | 278·7 | 282·7 | 286·7 | 290·6 | 294·6 | 298·6 | 302·6 | 306·6 | 310·5 | 314·5 | 4·0 |
| 181 | 43 318·5 | 322·5 | 326·5 | 330·4 | 334·4 | 338·4 | 342·4 | 346·3 | 350·3 | 354·2 | 4·0 |
| 182 | 358·2 | 362·2 | 366·1 | 370·1 | 374·0 | 378·0 | 381·9 | 385·9 | 389·8 | 393·8 | 4·0 |
| 183 | 397·7 | 401·6 | 405·6 | 409·5 | 413·5 | 417·4 | 421·3 | 425·3 | 429·2 | 433·2 | 3·9 |
| 184 | 43 437·1 | 441·0 | 444·9 | 448·9 | 452·8 | 456·7 | 460·6 | 464·5 | 468·5 | 472·4 | 3·9 |
| 185 | 476·3 | 480·2 | 484·1 | 488·0 | 491·9 | 495·8 | 499·7 | 503·6 | 507·5 | 511·4 | 3·9 |
| 186 | 515·3 | 519·2 | 523·1 | 526·9 | 530·8 | 534·7 | 538·6 | 542·5 | 546·3 | 550·2 | 3·9 |
| 187 | 43 554·1 | 558·0 | 561·9 | 565·7 | 569·6 | 573·5 | 577·4 | 581·2 | 585·1 | 588·9 | 3·9 |
| 188 | 592·8 | 596·7 | 600·5 | 604·4 | 608·2 | 612·1 | 615·9 | 619·8 | 623·6 | 627·5 | 3·9 |
| 189 | 631·3 | 635·1 | 639·0 | 642·8 | 646·7 | 650·5 | 654·3 | 658·2 | 662·0 | 665·9 | 3·8 |
| 190 | 43 669·7 | 673·5 | 677·4 | 681·2 | 685·1 | 688·9 | 692·7 | 696·5 | 700·4 | 704·2 | 3·8 |
| 191 | 708·0 | 711·8 | 715·6 | 719·5 | 723·3 | 727·1 | 730·9 | 734·7 | 738·6 | 742·4 | 3·8 |
| 192 | 746·2 | 750·0 | 753·8 | 757·6 | 761·4 | 765·2 | 769·0 | 772·8 | 776·6 | 780·4 | 3·8 |
| 193 | 43 784·2 | 788·0 | 791·8 | 795·6 | 799·4 | 803·2 | 807·0 | 810·8 | 814·5 | 818·3 | 3·8 |
| 194 | 822·1 | 825·9 | 829·6 | 833·4 | 837·1 | 840·9 | 844·7 | 848·4 | 852·2 | 855·9 | 3·8 |
| 195 | 859·7 | 863·5 | 867·2 | 871·0 | 874·7 | 878·5 | 882·2 | 886·0 | 889·7 | 893·5 | 3·8 |
| 196 | 43 897·2 | 900·9 | 904·7 | 908·4 | 912·2 | 915·9 | 919·6 | 923·3 | 927·1 | 930·8 | 3·7 |
| 197 | 934·5 | 938·2 | 941·9 | 945·7 | 949·4 | 953·1 | 956·8 | 960·5 | 964·2 | 967·9 | 3·7 |
| 198 | 971·6 | 975·3 | 979·0 | 982·6 | 986·3 | 990·0 | 993·7 | 997·4 | *001·0 | *004·7 | 3·7 |

## XXV. $S_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 199 | 44 008·4 | 012·1 | 015·7 | 019·4 | 023·0 | 026·7 | 030·4 | 034·0 | 037·7 | 041·3 | 3·7 |
| 200 | 045·0 | 048·6 | 052·3 | 055·9 | 059·6 | 063·2 | 066·8 | 070·5 | 074·1 | 077·8 | 3·6 |
| 201 | 081·4 | 085·0 | 088·6 | 092·3 | 095·9 | 099·5 | 103·1 | 106·7 | 110·4 | 114·0 | 3·6 |
| 202 | 44 117·6 | 121·2 | 124·8 | 128·4 | 132·0 | 135·6 | 139·2 | 142·8 | 146·3 | 149·9 | 3·6 |
| 203 | 153·5 | 157·1 | 160·7 | 164·2 | 167·8 | 171·4 | 175·0 | 178·5 | 182·1 | 185·6 | 3·6 |
| 204 | 189·2 | 192·7 | 196·3 | 199·8 | 203·4 | 206·9 | 210·4 | 213·9 | 217·5 | 221·0 | 3·5 |
| 205 | 44 224·5 | 228·0 | 231·5 | 235·1 | 238·6 | 242·1 | 245·6 | 249·1 | 252·6 | 256·1 | 3·5 |
| 206 | 259·6 | 263·1 | 266·6 | 270·1 | 273·6 | 277·1 | 280·6 | 284·1 | 287·5 | 291·0 | 3·5 |
| 207 | 294·5 | 298·0 | 301·4 | 304·9 | 308·3 | 311·8 | 315·2 | 318·7 | 322·1 | 325·6 | 3·5 |
| 208 | 44 329·0 | 332·4 | 335·9 | 339·3 | 342·8 | 346·2 | 349·6 | 353·0 | 356·5 | 359·9 | 3·4 |
| 209 | 363·3 | 366·7 | 370·1 | 373·5 | 376·9 | 380·3 | 383·7 | 387·1 | 390·4 | 393·8 | 3·4 |
| 210 | 397·2 | 400·6 | 404·0 | 407·3 | 410·7 | 414·1 | 417·5 | 420·8 | 424·2 | 427·5 | 3·4 |
| 211 | 44 430·9 | 434·3 | 437·6 | 441·0 | 444·3 | 447·7 | 451·0 | 454·4 | 457·7 | 461·1 | 3·4 |
| 212 | 464·4 | 467·7 | 471·0 | 474·4 | 477·7 | 481·0 | 484·3 | 487·6 | 490·9 | 494·2 | 3·3 |
| 213 | 497·5 | 500·8 | 504·1 | 507·4 | 510·7 | 514·0 | 517·3 | 520·6 | 523·8 | 527·1 | 3·3 |
| 214 | 44 530·4 | 533·7 | 537·0 | 540·2 | 543·5 | 546·8 | 550·1 | 553·3 | 556·6 | 559·8 | 3·3 |
| 215 | 563·1 | 566·4 | 569·6 | 572·9 | 576·1 | 579·4 | 582·6 | 585·8 | 589·1 | 592·3 | 3·2 |
| 216 | 595·5 | 598·7 | 601·9 | 605·2 | 608·4 | 611·6 | 614·8 | 618·0 | 621·3 | 624·5 | 3·2 |
| 217 | 44 627·7 | 630·9 | 634·1 | 637·3 | 640·5 | 643·7 | 646·9 | 650·1 | 653·2 | 656·4 | 3·2 |
| 218 | 659·6 | 662·8 | 666·0 | 669·1 | 672·3 | 675·5 | 678·7 | 681·8 | 685·0 | 688·1 | 3·2 |
| 219 | 691·3 | 694·5 | 697·6 | 700·8 | 703·9 | 707·1 | 710·2 | 713·4 | 716·5 | 719·7 | 3·2 |
| 220 | 44 722·8 | 725·9 | 729·1 | 732·2 | 735·4 | 738·5 | 741·6 | 744·7 | 747·9 | 751·0 | 3·1 |
| 221 | 754·1 | 757·2 | 760·3 | 763·5 | 766·6 | 769·7 | 772·8 | 775·9 | 779·1 | 782·2 | 3·1 |
| 222 | 785·3 | 788·4 | 791·5 | 794·6 | 797·7 | 800·8 | 803·9 | 807·0 | 810·1 | 813·2 | 3·1 |
| 223 | 44 816·3 | 819·4 | 822·5 | 825·5 | 828·6 | 831·7 | 834·8 | 837·9 | 840·9 | 844·0 | 3·1 |
| 224 | 847·1 | 850·2 | 853·2 | 856·3 | 859·3 | 862·4 | 865·5 | 868·5 | 871·6 | 874·6 | 3·1 |
| 225 | 877·7 | 880·8 | 883·8 | 886·9 | 889·9 | 893·0 | 896·1 | 899·1 | 902·2 | 905·2 | 3·1 |
| 226 | 44 908·3 | 911·3 | 914·4 | 917·4 | 920·5 | 923·5 | 926·5 | 929·6 | 932·6 | 935·7 | 3·0 |
| 227 | 938·7 | 941·7 | 944·8 | 947·8 | 950·9 | 953·9 | 957·0 | 960·0 | 963·1 | 966·1 | 3·0 |
| 228 | 969·2 | 972·2 | 975·3 | 978·3 | 981·4 | 984·4 | 987·4 | 990·5 | 993·5 | 996·6 | 3·0 |
| 229 | 44 999·6 | *002·6 | *005·7 | *008·7 | *011·8 | *014·8 | *017·8 | *020·9 | *023·9 | *027·0 | 3·0 |
| 230 | 45 030·0 | 033·0 | 036·1 | 039·1 | 042·2 | 045·2 | 048·2 | 051·3 | 054·3 | 057·4 | 3·0 |
| 231 | 060·4 | 063·4 | 066·4 | 069·5 | 072·5 | 075·5 | 078·5 | 081·6 | 084·6 | 087·7 | 3·0 |
| 232 | 45 090·7 | 093·7 | 096·8 | 099·8 | 102·9 | 105·9 | 108·9 | 112·0 | 115·0 | 118·1 | 3·0 |
| 233 | 121·1 | 124·1 | 127·2 | 130·2 | 133·3 | 136·3 | 139·3 | 142·3 | 145·4 | 148·4 | 3·0 |
| 234 | 151·4 | 154·4 | 157·5 | 160·5 | 163·6 | 166·6 | 169·6 | 172·6 | 175·7 | 178·7 | 3·0 |
| 235 | 45 181·7 | 184·7 | 187·8 | 190·8 | 193·9 | 196·9 | 199·9 | 203·0 | 206·0 | 209·1 | 3·0 |
| 236 | 212·1 | 215·1 | 218·2 | 221·2 | 224·3 | 227·3 | 230·3 | 233·4 | 236·4 | 239·5 | 3·0 |
| 237 | 242·5 | 245·5 | 248·6 | 251·6 | 254·7 | 257·7 | 260·7 | 263·8 | 266 8 | 269·9 | 3·0 |
| 238 | 45 272·9 | 275·9 | 279·0 | 282·0 | 285·1 | 288·1 | 291·2 | 294·2 | 297·3 | 300·3 | 3·0 |
| 239 | 303·4 | 306·4 | 309·5 | 312·5 | 315·6 | 318·6 | 321·6 | 324·7 | 327·7 | 330·8 | 3·0 |
| 240 | 333·8 | 336·8 | 339·9 | 342·9 | 346·0 | 349·0 | 352·1 | 355·1 | 358·2 | 361·2 | 3·0 |
| 241 | 45 364·3 | 367·3 | 370·4 | 373·4 | 376·5 | 379·5 | 382·6 | 385·6 | 388·7 | 391 7 | 3·0 |
| 242 | 394·8 | 397·8 | 400·9 | 403·9 | 407·0 | 410·0 | 413·0 | 416·1 | 419·1 | 422·2 | 3·0 |
| 243 | 425·2 | 428·2 | 431·3 | 434·3 | 437·4 | 440·4 | 443·5 | 446·5 | 449·6 | 452·6 | 3·0 |

## XXV. $S_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | Feet | + |
| 244 | 45 455·7 | 458·7 | 461·8 | 464·8 | 467·9 | 470·9 | 474·0 | 477·0 | 480·1 | 483·1 | 3·0 |
| 245 | 486·2 | 489·2 | 492·3 | 495·3 | 498·4 | 501·4 | 504·4 | 507·5 | 510·5 | 513·6 | 3·0 |
| 246 | 516·6 | 519·6 | 522·7 | 525·7 | 528·8 | 531·8 | 534·8 | 537·9 | 540·9 | 544·0 | 3·0 |
| 247 | 45 547·0 | 550·0 | 553·1 | 556·1 | 559·2 | 562·2 | 565·2 | 568·3 | 571·3 | 574·4 | 3·0 |
| 248 | 577·4 | 580·4 | 583·5 | 586·5 | 589·6 | 592·6 | 595·6 | 598·7 | 601·7 | 604·8 | 3·0 |
| 249 | 607·8 | 610·8 | 613·8 | 616·9 | 619·9 | 622·9 | 625·9 | 629·0 | 632·0 | 635·1 | 3·0 |
| 250 | 45 638·1 | 641·1 | 644·1 | 647·2 | 650·2 | 653·2 | 656·2 | 659·2 | 662·3 | 665·3 | 3·0 |
| 251 | 668·3 | 671·3 | 674·3 | 677·3 | 680·3 | 683·3 | 686·3 | 689·3 | 692·3 | 695·3 | 3·0 |
| 252 | 698·3 | 701·3 | 704·3 | 707·3 | 710·3 | 713·3 | 716·3 | 719·3 | 722·3 | 725·3 | 3·0 |
| 253 | 45 728·3 | 731·2 | 734·2 | 737·2 | 740·2 | 743·2 | 746·2 | 749·1 | 752·1 | 755·0 | 3·0 |
| 254 | 758·0 | 761·0 | 763·9 | 766·9 | 769·8 | 772·8 | 775·8 | 778·7 | 781·7 | 784·6 | 3·0 |
| 255 | 787·6 | 790·6 | 793·5 | 796·5 | 799·4 | 802·4 | 805·3 | 808·3 | 811·2 | 814·2 | 3·0 |
| 256 | 45 817·1 | 820·0 | 823·0 | 825·9 | 828·9 | 831·8 | 834·7 | 837·6 | 840·6 | 843·5 | 2·9 |
| 257 | 846·4 | 849·3 | 852·2 | 855·2 | 858·1 | 861·0 | 863·9 | 866·8 | 869·7 | 872·6 | 2·9 |
| 258 | 875·5 | 878·4 | 881·3 | 884·2 | 887·1 | 890·0 | 892·9 | 895·8 | 898·7 | 901·6 | 2·9 |
| 259 | 45 904·5 | 907·4 | 910·3 | 913·2 | 916·1 | 919·0 | 921·9 | 924·8 | 927·6 | 930·5 | 2·9 |
| 260 | 933·4 | 936·3 | 939·1 | 942·0 | 944·8 | 947·7 | 950·6 | 953·4 | 956·3 | 959·1 | 2·9 |
| 261 | 962·0 | 964·9 | 967·7 | 970·6 | 973·4 | 976·3 | 979·1 | 982·0 | 984·8 | 987·7 | 2·9 |
| 262 | 45 990·5 | 993·3 | 996·1 | 999·0 | *001·8 | *004·6 | *007·4 | *010·2 | *013·1 | *015·9 | 2·8 |
| 263 | 46 018·7 | 021·5 | 024·3 | 027·1 | 029·9 | 032·7 | 035·5 | 038·3 | 041·1 | 043·9 | 2·8 |
| 264 | 046·7 | 049·5 | 052·3 | 055·1 | 057·9 | 060·7 | 063·5 | 066·3 | 069·0 | 071·8 | 2·8 |
| 265 | 46 074·6 | 077·4 | 080·1 | 082·9 | 085·6 | 088·4 | 091·2 | 093·9 | 096·7 | 099·4 | 2·8 |
| 266 | 102·2 | 104·9 | 107·7 | 110·4 | 113·2 | 115·9 | 118·6 | 121·4 | 124·1 | 126·9 | 2·7 |
| 267 | 129·6 | 132·3 | 135·0 | 137·8 | 140·5 | 143·2 | 145·9 | 148·6 | 151·3 | 154·0 | 2·7 |
| 268 | 46 156·7 | 159·4 | 162·1 | 164·8 | 167·5 | 170·2 | 172·9 | 175·6 | 178·3 | 181·0 | 2·7 |
| 269 | 183·7 | 186·4 | 189·1 | 191·8 | 194·5 | 197·2 | 199·9 | 202·6 | 205·2 | 207·9 | 2·7 |
| 270 | 210·6 | 213·3 | 215·9 | 218·6 | 221·2 | 223·9 | 226·6 | 229·2 | 231·9 | 234·5 | 2·7 |
| 271 | 46 237·2 | 239·9 | 242·5 | 245·2 | 247·8 | 250·5 | 253·1 | 255·8 | 258·4 | 261·1 | 2·7 |
| 272 | 263·7 | 266·3 | 268·9 | 271·6 | 274·2 | 276·8 | 279·4 | 282·0 | 284·7 | 287·3 | 2·6 |
| 273 | 289·9 | 292·5 | 295·1 | 297·8 | 300·4 | 303·0 | 305·6 | 308·2 | 310·8 | 313·4 | 2·6 |
| 274 | 46 316·0 | 318·6 | 321·2 | 323·8 | 326·4 | 329·0 | 331·6 | 334·2 | 336·8 | 339·4 | 2·6 |
| 275 | 342·0 | 344·6 | 347·2 | 349·7 | 352·3 | 354·9 | 357·5 | 360·0 | 362·6 | 365·1 | 2·6 |
| 276 | 367·7 | 370·3 | 372·8 | 375·4 | 377·9 | 380·5 | 383·1 | 385·6 | 388·2 | 390·7 | 2·6 |
| 277 | 46 393·3 | 395·8 | 398·4 | 400·9 | 403·5 | 406·0 | 408·5 | 411·0 | 413·6 | 416·1 | 2·5 |
| 278 | 418·6 | 421·1 | 423·6 | 426·2 | 428·7 | 431·2 | 433·7 | 436·2 | 438·8 | 441·3 | 2·5 |
| 279 | 443·8 | 446·3 | 448·8 | 451·3 | 453·8 | 456·3 | 458·8 | 461·3 | 463·8 | 466·3 | 2·5 |
| 280 | 46 468·8 | 471·3 | 473·8 | 476·2 | 478·7 | 481·2 | 483·7 | 486·2 | 488·6 | 491·1 | 2·5 |
| 281 | 493·6 | 496·1 | 498·6 | 501·0 | 503·5 | 506·0 | 508·5 | 510·9 | 513·4 | 515·8 | 2·5 |
| 282 | 518·3 | 520·7 | 523·2 | 525·6 | 528·1 | 530·5 | 532·9 | 535·4 | 537·8 | 540·3 | 2·4 |
| 283 | 46 542·7 | 545·1 | 547·6 | 550·0 | 552·5 | 554·9 | 557·3 | 559·7 | 562·2 | 564·6 | 2·4 |
| 284 | 567·0 | 569·4 | 571·8 | 574·3 | 576·7 | 579·1 | 581·5 | 583·9 | 586·4 | 588·8 | 2·4 |
| 285 | 591·2 | 593·6 | 596·0 | 598·4 | 600·8 | 603·2 | 605·6 | 608·0 | 610·4 | 612·8 | 2·4 |
| 286 | 46 615·2 | 617·6 | 620·0 | 622·3 | 624·7 | 627·1 | 629·5 | 631·9 | 634·2 | 636·6 | 2·4 |
| 287 | 639·0 | 641·4 | 643·7 | 646·1 | 648·4 | 650·8 | 653·2 | 655·5 | 657·9 | 660·2 | 2·4 |
| 288 | 662·6 | 664·9 | 667·3 | 669·6 | 672·0 | 674·3 | 676·6 | 679·0 | 681·3 | 683·7 | 2·3 |
| 289 | 46 686·0 | 688·3 | 690·7 | 693·0 | 695·4 | 697·7 | 700·0 | 702·3 | 704·7 | 707·0 | 2·3 |
| 290 | 709·3 | 711·6 | 713·9 | 716·3 | 718·6 | 720·9 | 723·2 | 725·5 | 727·9 | 730·2 | 2·3 |

## XXVI. $T_v$ for Ogival-headed Projectiles. ($w = 534{\cdot}22$ grains.)

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 10 | 9·9 | 11·6 | 13·2 | 14·8 | 16·4 | 17·9 | 19·4 | 20·9 | 22·3 | 23·7 | 1·5 |
| 11 | 25·1 | 26·5 | 27·8 | 29·1 | 30·3 | 31·5 | 32·8 | 34·0 | 35·2 | 36·4 | 1·2 |
| 12 | 37·5 | 38·6 | 39·7 | 40·8 | 41·9 | 43·0 | 44·0 | 45·1 | 46·1 | 47·1 | 1·1 |
| 13 | 48·1 | 49·0 | 50·0 | 50·9 | 51·9 | 52·8 | 53·7 | 54·6 | 55·4 | 56·3 | 0·9 |
| 14 | 57·2 | 58·0 | 58·8 | 59·6 | 60·4 | 61·2 | 62·0 | 62·7 | 63·5 | 64·2 | 0·8 |
| 15 | 65·0 | 65·7 | 66·4 | 67·2 | 67·9 | 68·6 | 69·3 | 69·9 | 70·6 | 71·2 | 0·7 |
| 16 | 71·91 | 72·55 | 73·18 | 73·81 | 74·43 | 75·04 | 75·64 | 76·24 | 76·83 | 77·41 | ·61 |
| 17 | 77·99 | 78·56 | 79·12 | 79 67 | 80·22 | 80·76 | 81·29 | 81·82 | 82·35 | 82·87 | ·54 |
| 18 | 83·39 | 83·90 | 84·40 | 84·90 | 85·39 | 85·88 | 86·36 | 86·84 | 87·31 | 87·78 | ·49 |
| 19 | 88·24 | 88·69 | 89·14 | 89·58 | 90·02 | 90·46 | 90·89 | 91·32 | 91·74 | 92·16 | ·44 |
| 20 | 92·57 | 92·98 | 93·39 | 93·79 | 94·19 | 94·59 | 94·98 | 95·37 | 95·75 | 96·13 | ·40 |
| 21 | 96·51 | 96·88 | 97·26 | 97·63 | 97·99 | 98·35 | 98·70 | 99·05 | 99·40 | 99·75 | ·36 |
| 22 | 1 00·09 | 00·43 | 00·77 | 01·10 | 01·43 | 01·76 | 02·08 | 02·40 | 02·72 | 03·04 | ·33 |
| 23 | 03·35 | 03·66 | 03·97 | 04·27 | 04·58 | 04·88 | 05·18 | 05·47 | 05·77 | 06·06 | ·30 |
| 24 | 06·35 | 06·64 | 06·92 | 07·20 | 07·48 | 07·75 | 08·03 | 08·30 | 08·57 | 08·84 | ·28 |
| 25 | 1 09·10 | 09·37 | 09·63 | 09 89 | 10·15 | 10·40 | 10·66 | 10·91 | 11·16 | 11·41 | ·26 |
| 26 | 11·65 | 11·90 | 12·14 | 12·38 | 12·62 | 12·85 | 13·09 | 13·32 | 13·55 | 13·78 | ·24 |
| 27 | 14 00 | 14·23 | 14·45 | 14·68 | 14·90 | 15·12 | 15·34 | 15·55 | 15·77 | 15·98 | ·22 |
| 28 | 1 16·19 | 16·40 | 16·61 | 16·81 | 17·02 | 17·22 | 17·43 | 17·63 | 17·83 | 18·03 | ·20 |
| 29 | 18·22 | 18·42 | 18·61 | 18·81 | 19·00 | 19·19 | 19·38 | 19·57 | 19·75 | 19·94 | ·19 |
| 30 | 20·12 | 20·31 | 20·49 | 20·67 | 20·85 | 21·02 | 21·20 | 21·38 | 21·56 | 21·73 | ·18 |
| 31 | 1 21·90 | 22·07 | 22·24 | 22·41 | 22·58 | 22·75 | 22·92 | 23·08 | 23·25 | 23·41 | ·17 |
| 32 | 23·57 | 23·73 | 23·89 | 24·05 | 24·21 | 24·36 | 24·52 | 24·67 | 24·83 | 24·98 | ·16 |
| 33 | 25·13 | 25·28 | 25·43 | 25·58 | 25·73 | 25·88 | 26·03 | 26·17 | 26·32 | 26·46 | ·15 |
| 34 | 1 26·60 | 26·74 | 26·88 | 27·02 | 27·16 | 27·30 | 27·44 | 27·58 | 27·71 | 27·85 | ·14 |
| 35 | 27·99 | 28·12 | 28·26 | 28·39 | 28·53 | 28·66 | 28·79 | 28·92 | 29·05 | 29·18 | ·13 |
| 36 | 29·31 | 29·44 | 29·57 | 29·69 | 29·82 | 29·94 | 30·07 | 30·19 | 30·31 | 30·43 | ·12 |
| 37 | 1 30·55 | 30·67 | 30·79 | 30·91 | 31·02 | 31·14 | 31·26 | 31·37 | 31·49 | 31·60 | ·12 |
| 38 | 31·72 | 31·83 | 31·95 | 32 06 | 32·18 | 32·29 | 32·40 | 32·51 | 32 62 | 32·73 | ·11 |
| 39 | 32·84 | 32·95 | 33·06 | 33·17 | 33·27 | 33·38 | 33·48 | 33·59 | 33·69 | 33·80 | ·11 |
| 40 | 1 33·90 | 34·00 | 34·11 | 34·21 | 34·31 | 34·41 | 34·51 | 34·61 | 34·71 | 34·81 | ·10 |
| 41 | 34·91 | 35·01 | 35·10 | 35·20 | 35·29 | 35·39 | 35·48 | 35·58 | 35·67 | 35·77 | ·10 |
| 42 | 35·86 | 35·96 | 36·05 | 36·14 | 36·24 | 36·33 | 36·42 | 36·51 | 36·60 | 36·69 | ·09 |
| 43 | 1 36·78 | 36·87 | 36·96 | 37·05 | 37·14 | 37·22 | 37·31 | 37·39 | 37·48 | 37·56 | ·09 |
| 44 | 37·65 | 37·73 | 37·82 | 37·90 | 37·99 | 38·07 | 38·16 | 38·24 | 38·32 | 38·41 | ·08 |
| 45 | 38·49 | 38·57 | 38·65 | 38·73 | 38·81 | 38·89 | 38·97 | 39·05 | 39·13 | 39·21 | ·08 |
| 46 | 1 39·29 | 39·36 | 39·44 | 39·52 | 39·59 | 39·67 | 39·75 | 39·82 | 39·90 | 39·97 | ·08 |
| 47 | 40·05 | 40·12 | 40·20 | 40 27 | 40·35 | 40·42 | 40·49 | 40·57 | 40 64 | 40·71 | ·07 |
| 48 | 40·78 | 40·86 | 40·93 | 41·00 | 41·07 | 41·14 | 41·21 | 41·28 | 41·35 | 41·42 | ·07 |
| 49 | 1 41·49 | 41·56 | 41·63 | 41·70 | 41·76 | 41·83 | 41·90 | 41·96 | 42·03 | 42·09 | ·07 |
| 50 | 42·16 | 42·23 | 42·29 | 42·36 | 42·42 | 42·49 | 42·56 | 42·62 | 42·69 | 42·75 | ·07 |
| 51 | 42·81 | 42·87 | 42·94 | 43·00 | 43·06 | 43·12 | 43·19 | 43·25 | 43·31 | 43·37 | ·06 |
| 52 | 14 3·430 | 3·491 | 3·552 | 3·613 | 3·673 | 3·733 | 3·793 | 3·853 | 3·912 | 3·971 | ·060 |
| 53 | 4·030 | 4·089 | 4·147 | 4·205 | 4·263 | 4·321 | 4·379 | 4·436 | 4·493 | 4·550 | ·058 |
| 54 | 4·607 | 4·664 | 4·720 | 4·776 | 4·832 | 4·888 | 4·944 | 4·999 | 5·054 | 5·109 | ·056 |
| 55 | 14 5·164 | 5·219 | 5·273 | 5·327 | 5·381 | 5·435 | 5·489 | 5·542 | 5·595 | 5·648 | ·054 |
| 56 | 5·701 | 5·754 | 5·806 | 5·858 | 5·910 | 5·962 | 6·014 | 6·065 | 6·117 | 6·168 | ·052 |
| 57 | 6·219 | 6·270 | 6·321 | 6·371 | 6·422 | 6·472 | 6·522 | 6·572 | 6·621 | 6·671 | ·050 |

## XXVI. $T_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 58 | 146·720 | 6·769 | 6·818 | 6·866 | 6·915 | 6·963 | 7·011 | 7·059 | 7·107 | 7·154 | 48 |
| 59 | 7·202 | 7·249 | 7·296 | 7·343 | 7·390 | 7·437 | 7·483 | 7·530 | 7·576 | 7·622 | 47 |
| 60 | 7·668 | 7·714 | 7·759 | 7·805 | 7·850 | 7·896 | 7·941 | 7·986 | 8·031 | 8·076 | 45 |
| 61 | 148·121 | 8·165 | 8·209 | 8·253 | 8·297 | 8 341 | 8·384 | 8·428 | 8·471 | 8·515 | 44 |
| 62 | 8·558 | 8·601 | 8·643 | 8·686 | 8·728 | 8·771 | 8·813 | 8·855 | 8·897 | 8·939 | 42 |
| 63 | 8·981 | 9·022 | 9·064 | 9·105 | 9·147 | 9·188 | 9·229 | 9·269 | 9·310 | 9·350 | 41 |
| 64 | 149·391 | 9·431 | 9·471 | 9·510 | 9·550 | 9·590 | 9·629 | 9·669 | 9·708 | 9·748 | 40 |
| 65 | 9·787 | 9·826 | 9·865 | 9·903 | 9·942 | 9·981 | *0·019 | *0·057 | *0·096 | *0·134 | 39 |
| 66 | 150·172 | 0·210 | 0·248 | 0·285 | 0·323 | 0·361 | 0·398 | 0·436 | 0·473 | 0·511 | 38 |
| 67 | 150·548 | 0·585 | 0·621 | 0·658 | 0·694 | 0·731 | 0·767 | 0·803 | 0·838 | 0·874 | 36 |
| 68 | 0·910 | 0·945 | 0·981 | 1·016 | 1·052 | 1·087 | 1·122 | 1·157 | 1·192 | 1·227 | 35 |
| 69 | 1·262 | 1·296 | 1·331 | 1·365 | 1·400 | 1·434 | 1·468 | 1·502 | 1·536 | 1·570 | 34 |
| 70 | 151·604 | 1·637 | 1·671 | 1·704 | 1·738 | 1·771 | 1·804 | 1·837 | 1·870 | 1·903 | 33 |
| 71 | 1·936 | 1·969 | 2·001 | 2·034 | 2·066 | 2·099 | 2·131 | 2·163 | 2·196 | 2·228 | 32 |
| 72 | 2·260 | 2·292 | 2·323 | 2·355 | 2·386 | 2·418 | 2·449 | 2·480 | 2·512 | 2·543 | 31 |
| 73 | 152·574 | 2·605 | 2·636 | 2·666 | 2·697 | 2·728 | 2·758 | 2·789 | 2·819 | 2·850 | 31 |
| 74 | 2·880 | 2·910 | 2·940 | 2·969 | 2·999 | 3·029 | 3·059 | 3·088 | 3·118 | 3·147 | 30 |
| 75 | 3·177 | 3·206 | 3·236 | 3·265 | 3·295 | 3·324 | 3·353 | 3·382 | 3·410 | 3·439 | 29 |
| 76 | 153·468 | 3·497 | 3·525 | 3·554 | 3·582 | 3·611 | 3·639 | 3·667 | 3·695 | 3·723 | 28 |
| 77 | 3·751 | 3·779 | 3·806 | 3·834 | 3·861 | 3·889 | 3·916 | 3·943 | 3·971 | 3·998 | 27 |
| 78 | 4·025 | 4·052 | 4·079 | 4·107 | 4·134 | 4·161 | 4·188 | 4·215 | 4·241 | 4·268 | 27 |
| 79 | 154·295 | 4·321 | 4·347 | 4·374 | 4·400 | 4·426 | 4·452 | 4·478 | 4·504 | 4·530 | 26 |
| 80 | 4·556 | 4·582 | 4·607 | 4·633 | 4·658 | 4·684 | 4·709 | 4·735 | 4·760 | 4·786 | 26 |
| 81 | 4·810 | 4·836 | 4·861 | 4·886 | 4·911 | 4·935 | 4·961 | 4·986 | 5·010 | 5·035 | 25 |
| 82 | 155·060 | 5·084 | 5·109 | 5·133 | 5·158 | 5·182 | 5·206 | 5·230 | 5·253 | 5·277 | 24 |
| 83 | 5·301 | 5·325 | 5·348 | 5·372 | 5·395 | 5·419 | 5·442 | 5·465 | 5·489 | 5·512 | 23 |
| 84 | 5·535 | 5·558 | 5·581 | 5·603 | 5·626 | 5·649 | 5·671 | 5·694 | 5·716 | 5·739 | 23 |
| 85 | 155·761 | 5·783 | 5·805 | 5·826 | 5·848 | 5·870 | 5·891 | 5·913 | 5·934 | 5·956 | 22 |
| 86 | 5·977 | 5·998 | 6·019 | 6·041 | 6·062 | 6·083 | 6·104 | 6·125 | 6·146 | 6·167 | 21 |
| 87 | 6·188 | 6·208 | 6·229 | 6·249 | 6·270 | 6·290 | 6·310 | 6·330 | 6·350 | 6·370 | 20 |
| 88 | 156·390 | 6·410 | 6·430 | 6·449 | 6·469 | 6·489 | 6·508 | 6·528 | 6·547 | 6·567 | 20 |
| 89 | 6·586 | 6·605 | 6·624 | 6·644 | 6·663 | 6·682 | 6·701 | 6·720 | 6·738 | 6·757 | 19 |
| 90 | 6·776 | 6·794 | 6·813 | 6·831 | 6·850 | 6·868 | 6·886 | 6·904 | 6·923 | 6·941 | 18 |
| 91 | 156·959 | 6·977 | 6·995 | 7·012 | 7·030 | 7·048 | 7·066 | 7·083 | 7·101 | 7·118 | 18 |
| 92 | 7·136 | 7·153 | 7·171 | 7·188 | 7·206 | 7·223 | 7·240 | 7·257 | 7·274 | 7·291 | 17 |
| 93 | 7·308 | 7·325 | 7·342 | 7·358 | 7·375 | 7·392 | 7·409 | 7·425 | 7·442 | 7·458 | 17 |
| 94 | 157·475 | 7·491 | 7·507 | 7·524 | 7·540 | 7·556 | 7·572 | 7·588 | 7·604 | 7·620 | 16 |
| 95 | 7·636 | 7·652 | 7·667 | 7·683 | 7·698 | 7·714 | 7·730 | 7·745 | 7·761 | 7·776 | 16 |
| 96 | 7·792 | 7·807 | 7·822 | 7·838 | 7·853 | 7·868 | 7·883 | 7·898 | 7·913 | 7·928 | 15 |
| 97 | 157·943 | 7·958 | 7·973 | 7·987 | 8·002 | 8·017 | 8·032 | 8·046 | 8·061 | 8·075 | 15 |
| 98 | 8·090 | 8·104 | 8·118 | 8·133 | 8·147 | 8·161 | 8·175 | 8·189 | 8·204 | 8·218 | 14 |
| 99 | 8·232 | 8·246 | 8·260 | 8·273 | 8·287 | 8·301 | 8·315 | 8·329 | 8·342 | 8·356 | 14 |
| 100 | 158·370 | 8·383 | 8·397 | 8·410 | 8·424 | 8·437 | 8·450 | 8·463 | 8·477 | 8·490 | 13 |
| 101 | 8·503 | 8·516 | 8·529 | 8·542 | 8·555 | 8·568 | 8·581 | 8·594 | 8·606 | 8·619 | 13 |
| 102 | 8·632 | 8·645 | 8·657 | 8·670 | 8·682 | 8·695 | 8·707 | 8·719 | 8·732 | 8·744 | 12 |
| 103 | 158·756 | 8·768 | 8·779 | 8·791 | 8·802 | 8·814 | 8·825 | 8·836 | 8·848 | 8·859 | 11 |
| 104 | 8·870 | 8·881 | 8·892 | 8·902 | 8 913 | 8·924 | 8·934 | 8·944 | 8·954 | 8·964 | 10 |
| 105 | 8·974 | 8·984 | 8·994 | 9·003 | 9·013 | 9·023 | 9·032 | 9·041 | 9·051 | 9·060 | 10 |

## XXVI. $T_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 106 | 1 5 9·069 | 9·078 | 9·087 | 9·095 | 9·104 | 9·113 | 9·121 | 9·130 | 9·138 | 9·147 | 9 |
| 107 | 9·155 | 9·163 | 9·171 | 9·179 | 9·187 | 9·195 | 9·203 | 9·211 | 9·218 | 9·226 | 8 |
| 108 | 9·234 | 9·242 | 9·250 | 9·257 | 9·265 | 9·273 | 9·281 | 9·288 | 9·296 | 9·303 | 8 |
| 109 | 1 5 9·311 | 9·318 | 9·325 | 9·333 | 9·340 | 9·347 | 9·354 | 9·361 | 9·368 | 9·375 | 7 |
| 110 | 9·382 | 9·389 | 9·396 | 9·403 | 9·410 | 9·417 | 9·424 | 9·431 | 9·437 | 9·444 | 7 |
| 111 | 9·451 | 9·458 | 9·464 | 9·471 | 9·477 | 9·484 | 9·491 | 9·497 | 9·504 | 9·510 | 7 |
| 112 | 1 5 9·517 | 9·523 | 9·530 | 9·536 | 9·543 | 9·549 | 9·555 | 9·562 | 9·568 | 9·575 | 6 |
| 113 | 9·581 | 9·587 | 9·594 | 9·600 | 9·607 | 9·613 | 9·619 | 9·625 | 9·632 | 9·638 | 6 |
| 114 | 9·644 | 9·650 | 9·656 | 9·662 | 9·668 | 9·674 | 9·680 | 9·686 | 9·692 | 9·698 | 6 |
| 115 | 1 5 9·704 | 9·710 | 9·716 | 9·722 | 9·728 | 9·734 | 9·740 | 9·746 | 9·752 | 9·758 | 6 |
| 116 | 9·764 | 9·770 | 9·776 | 9·781 | 9·787 | 9·793 | 9·799 | 9·805 | 9·810 | 9·816 | 6 |
| 117 | 9·822 | 9·828 | 9·833 | 9·839 | 9·844 | 9·850 | 9·856 | 9·861 | 9·867 | 9·872 | 6 |
| 118 | 1 5 9·878 | 9·883 | 9·889 | 9·894 | 9·900 | 9·905 | 9·910 | 9·916 | 9·921 | 9·927 | 5 |
| 119 | 9·932 | 9·937 | 9·943 | 9·948 | 9·954 | 9·959 | 9·964 | 9·970 | 9·976 | 9·981 | 5 |
| 120 | 9·986 | 9·991 | 9·996 | *0·002 | *0·007 | *0·012 | *0·017 | *0·022 | *0·028 | *0·033 | 5 |
| 121 | 160· 0381 | 0432 | 0483 | 0535 | 0586 | 0637 | 0688 | 0738 | 0789 | 0839 | 51 |
| 122 | 0890 | 0940 | 0990 | 1040 | 1090 | 1140 | 1189 | 1239 | 1288 | 1338 | 50 |
| 123 | 1387 | 1436 | 1484 | 1533 | 1581 | 1630 | 1678 | 1726 | 1775 | 1823 | 48 |
| 124 | 160· 1871 | 1919 | 1966 | 2014 | 2061 | 2109 | 2156 | 2203 | 2250 | 2297 | 47 |
| 125 | 2344 | 2390 | 2437 | 2483 | 2529 | 2576 | 2622 | 2668 | 2713 | 2759 | 46 |
| 126 | 2805 | 2850 | 2896 | 2941 | 2987 | 3032 | 3077 | 3122 | 3166 | 3211 | 45 |
| 127 | 160· 3256 | 3300 | 3344 | 3389 | 3433 | 3477 | 3521 | 3565 | 3608 | 3652 | 44 |
| 128 | 3696 | 3739 | 3782 | 3826 | 3869 | 3912 | 3955 | 3998 | 4040 | 4083 | 43 |
| 129 | 4126 | 4168 | 4210 | 4253 | 4295 | 4337 | 4379 | 4421 | 4462 | 4504 | 42 |
| 130 | 160· 4546 | 4587 | 4629 | 4670 | 4712 | 4753 | 4794 | 4835 | 4876 | 4917 | 41 |
| 131 | 4958 | 4999 | 5039 | 5080 | 5120 | 5161 | 5201 | 5241 | 5282 | 5322 | 40 |
| 132 | 5362 | 5402 | 5442 | 5481 | 5521 | 5561 | 5600 | 5639 | 5679 | 5718 | 40 |
| 133 | 160· 5757 | 5796 | 5835 | 5874 | 5913 | 5952 | 5991 | 6029 | 6067 | 6106 | 39 |
| 134 | 6145 | 6183 | 6222 | 6260 | 6299 | 6337 | 6375 | 6413 | 6450 | 6488 | 38 |
| 135 | 6526 | 6564 | 6601 | 6639 | 6676 | 6714 | 6751 | 6788 | 6826 | 6863 | 37 |
| 136 | 160· 6900 | 6937 | 6974 | 7011 | 7048 | 7085 | 7122 | 7158 | 7195 | 7231 | 37 |
| 137 | 7268 | 7304 | 7340 | 7377 | 7413 | 7449 | 7485 | 7521 | 7557 | 7593 | 36 |
| 138 | 7629 | 7665 | 7700 | 7736 | 7771 | 7807 | 7842 | 7878 | 7913 | 7949 | 36 |
| 139 | 160· 7984 | 8019 | 8054 | 8089 | 8124 | 8159 | 8194 | 8229 | 8263 | 8298 | 35 |
| 140 | 8333 | 8368 | 8402 | 8437 | 8471 | 8506 | 8540 | 8574 | 8609 | 8643 | 34 |
| 141 | 8677 | 8711 | 8745 | 8778 | 8812 | 8846 | 8880 | 8914 | 8947 | 8981 | 34 |
| 142 | 160· 9015 | 9048 | 9082 | 9115 | 9149 | 9182 | 9215 | 9248 | 9282 | 9315 | 33 |
| 143 | 9348 | 9381 | 9414 | 9447 | 9480 | 9513 | 9546 | 9578 | 9611 | 9643 | 33 |
| 144 | 9676 | 9709 | 9741 | 9774 | 9806 | 9839 | 9871 | 9904 | 9936 | 9968 | 32 |
| 145 | 161· 0000 | 0032 | 0064 | 0096 | 0128 | 0160 | 0192 | 0224 | 0255 | 0287 | 32 |
| 146 | 0319 | 0351 | 0382 | 0414 | 0445 | 0477 | 0508 | 0540 | 0571 | 0603 | 32 |
| 147 | 0634 | 0665 | 0696 | 0728 | 0759 | 0790 | 0821 | 0852 | 0882 | 0913 | 31 |
| 148 | 161· 0944 | 0975 | 1006 | 1036 | 1067 | 1098 | 1129 | 1159 | 1190 | 1220 | 31 |
| 149 | 1251 | 1281 | 1312 | 1342 | 1373 | 1403 | 1433 | 1463 | 1494 | 1524 | 30 |
| 150 | 1554 | 1584 | 1614 | 1644 | 1674 | 1704 | 1734 | 1764 | 1793 | 1823 | 30 |
| 151 | 161· 1853 | 1883 | 1913 | 1942 | 1972 | 2002 | 2031 | 2061 | 2090 | 2120 | 30 |
| 152 | 2149 | 2178 | 2208 | 2237 | 2267 | 2296 | 2325 | 2354 | 2384 | 2413 | 29 |
| 153 | 2442 | 2471 | 2500 | 2529 | 2558 | 2587 | 2616 | 2645 | 2673 | 2702 | 29 |

## XXVI. $T_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 154 | 161·2731 | 2760 | 2788 | 2817 | 2845 | 2874 | 2902 | 2931 | 2959 | 2988 | 29 |
| 155 | 3016 | 3044 | 3073 | 3101 | 3130 | 3158 | 3186 | 3214 | 3243 | 3271 | 28 |
| 156 | 3299 | 3327 | 3355 | 3383 | 3411 | 3439 | 3467 | 3495 | 3523 | 3551 | 28 |
| 157 | 161·3579 | 3607 | 3635 | 3662 | 3690 | 3718 | 3746 | 3773 | 3801 | 3828 | 28 |
| 158 | 3856 | 3883 | 3911 | 3938 | 3966 | 3993 | 4020 | 4047 | 4075 | 4102 | 27 |
| 159 | 4129 | 4156 | 4183 | 4211 | 4238 | 4265 | 4292 | 4319 | 4346 | 4373 | 27 |
| 160 | 161·4400 | 4427 | 4454 | 4481 | 4508 | 4535 | 4562 | 4588 | 4615 | 4641 | 27 |
| 161 | 4668 | 4695 | 4721 | 4748 | 4774 | 4801 | 4827 | 4854 | 4880 | 4907 | 27 |
| 162 | 4933 | 4959 | 4986 | 5012 | 5039 | 5065 | 5091 | 5117 | 5144 | 5170 | 26 |
| 163 | 161·5196 | 5222 | 5248 | 5275 | 5301 | 5327 | 5353 | 5379 | 5404 | 5430 | 26 |
| 164 | 5456 | 5482 | 5508 | 5533 | 5559 | 5585 | 5611 | 5636 | 5662 | 5687 | 26 |
| 165 | 5713 | 5739 | 5764 | 5790 | 5815 | 5841 | 5866 | 5892 | 5917 | 5943 | 26 |
| 166 | 161·5968 | 5993 | 6018 | 6044 | 6069 | 6094 | 6119 | 6144 | 6170 | 6195 | 25 |
| 167 | 6220 | 6245 | 6270 | 6295 | 6320 | 6345 | 6370 | 6395 | 6420 | 6445 | 25 |
| 168 | 6470 | 6495 | 6520 | 6544 | 6569 | 6594 | 6619 | 6643 | 6668 | 6692 | 25 |
| 169 | 161·6717 | 6742 | 6766 | 6791 | 6815 | 6840 | 6864 | 6889 | 6913 | 6938 | 25 |
| 170 | 6962 | 6986 | 7010 | 7035 | 7059 | 7083 | 7107 | 7131 | 7156 | 7180 | 24 |
| 171 | 7204 | 7228 | 7252 | 7277 | 7301 | 7325 | 7349 | 7373 | 7397 | 7421 | 24 |
| 172 | 161·7445 | 7469 | 7493 | 7516 | 7540 | 7564 | 7588 | 7612 | 7635 | 7659 | 24 |
| 173 | 7683 | 7707 | 7730 | 7754 | 7777 | 7801 | 7825 | 7848 | 7872 | 7895 | 24 |
| 174 | 7919 | 7942 | 7966 | 7989 | 8013 | 8036 | 8059 | 8082 | 8106 | 8129 | 23 |
| 175 | 161·8152 | 8175 | 8198 | 8222 | 8245 | 8268 | 8291 | 8314 | 8338 | 8361 | 23 |
| 176 | 8384 | 8407 | 8430 | 8453 | 8476 | 8499 | 8522 | 8545 | 8567 | 8590 | 23 |
| 177 | 8613 | 8636 | 8658 | 8681 | 8703 | 8726 | 8749 | 8771 | 8794 | 8816 | 23 |
| 178 | 161·8839 | 8862 | 8884 | 8907 | 8929 | 8952 | 8974 | 8997 | 9019 | 9042 | 23 |
| 179 | 9064 | 9086 | 9108 | 9131 | 9153 | 9175 | 9197 | 9219 | 9242 | 9264 | 22 |
| 180 | 9286 | 9308 | 9330 | 9353 | 9375 | 9397 | 9419 | 9441 | 9463 | 9485 | 22 |
| 181 | 161·9507 | 9529 | 9551 | 9572 | 9594 | 9616 | 9638 | 9660 | 9681 | 9703 | 22 |
| 182 | 9725 | 9747 | 9769 | 9790 | 9812 | 9834 | 9856 | 9877 | 9899 | 9920 | 22 |
| 183 | 9942 | 9964 | 9985 | *0007 | *0028 | *0050 | *0071 | *0093 | *0114 | *0136 | 22 |
| 184 | 162·0157 | 0178 | 0199 | 0221 | 0242 | 0263 | 0284 | 0305 | 0327 | 0348 | 21 |
| 185 | 0369 | 0390 | 0411 | 0432 | 0453 | 0474 | 0495 | 0516 | 0537 | 0558 | 21 |
| 186 | 0579 | 0600 | 0621 | 0642 | 0663 | 0684 | 0705 | 0726 | 0746 | 0767 | 21 |
| 187 | 162·0788 | 0809 | 0829 | 0850 | 0870 | 0891 | 0912 | 0932 | 0953 | 0973 | 21 |
| 188 | 0994 | 1014 | 1035 | 1055 | 1076 | 1096 | 1116 | 1137 | 1157 | 1178 | 20 |
| 189 | 1198 | 1218 | 1239 | 1259 | 1280 | 1300 | 1320 | 1340 | 1361 | 1381 | 20 |
| 190 | 162·1401 | 1421 | 1441 | 1461 | 1481 | 1501 | 1521 | 1541 | 1562 | 1582 | 20 |
| 191 | 1602 | 1622 | 1642 | 1662 | 1682 | 1702 | 1722 | 1742 | 1761 | 1781 | 20 |
| 192 | 1801 | 1821 | 1841 | 1860 | 1880 | 1900 | 1920 | 1940 | 1959 | 1979 | 20 |
| 193 | 162·1999 | 2019 | 2038 | 2058 | 2077 | 2097 | 2116 | 2136 | 2155 | 2175 | 20 |
| 194 | 2194 | 2213 | 2233 | 2252 | 2272 | 2291 | 2310 | 2330 | 2349 | 2369 | 19 |
| 195 | 2388 | 2407 | 2426 | 2446 | 2465 | 2484 | 2503 | 2522 | 2542 | 2561 | 19 |
| 196 | 162·2580 | 2599 | 2618 | 2637 | 2656 | 2675 | 2694 | 2713 | 2731 | 2750 | 19 |
| 197 | 2769 | 2788 | 2807 | 2825 | 2844 | 2863 | 2882 | 2901 | 2919 | 2938 | 19 |
| 198 | 2957 | 2976 | 2994 | 3013 | 3031 | 3050 | 3069 | 3087 | 3106 | 3124 | 19 |
| 199 | 162·3143 | 3161 | 3180 | 3198 | 3217 | 3235 | 3253 | 3271 | 3290 | 3308 | 18 |
| 200 | 3326 | 3344 | 3362 | 3381 | 3399 | 3417 | 3435 | 3453 | 3472 | 3490 | 18 |
| 201 | 3508 | 3526 | 3544 | 3562 | 3580 | 3598 | 3616 | 3634 | 3651 | 3669 | 18 |

## XXVI. $T_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 202 | 162·3687 | 3705 | 3723 | 3740 | 3758 | 3776 | 3794 | 3811 | 3829 | 3846 | 18 |
| 203 | 3864 | 3882 | 3899 | 3917 | 3934 | 3952 | 3969 | 3987 | 4004 | 4022 | 18 |
| 204 | 4039 | 4056 | 4074 | 4091 | 4109 | 4126 | 4143 | 4160 | 4178 | 4195 | 17 |
| 205 | 162·4212 | 4229 | 4246 | 4264 | 4281 | 4298 | 4315 | 4332 | 4349 | 4366 | 17 |
| 206 | 4383 | 4400 | 4417 | 4434 | 4451 | 4468 | 4485 | 4502 | 4518 | 4535 | 17 |
| 207 | 4552 | 4569 | 4586 | 4602 | 4619 | 4636 | 4653 | 4669 | 4686 | 4702 | 17 |
| 208 | 162·4719 | 4735 | 4752 | 4768 | 4785 | 4801 | 4817 | 4834 | 4850 | 4867 | 16 |
| 209 | 4883 | 4899 | 4915 | 4932 | 4948 | 4964 | 4980 | 4996 | 5013 | 5029 | 16 |
| 210 | 5045 | 5061 | 5077 | 5093 | 5109 | 5125 | 5141 | 5157 | 5173 | 5189 | 16 |
| 211 | 162·5205 | 5221 | 5237 | 5252 | 5268 | 5284 | 5300 | 5316 | 5331 | 5347 | 16 |
| 212 | 5363 | 5379 | 5394 | 5410 | 5425 | 5441 | 5457 | 5472 | 5488 | 5503 | 16 |
| 213 | 5519 | 5535 | 5550 | 5566 | 5581 | 5597 | 5612 | 5628 | 5643 | 5659 | 16 |
| 214 | 162·5674 | 5689 | 5704 | 5720 | 5735 | 5750 | 5765 | 5780 | 5796 | 5811 | 15 |
| 215 | 5826 | 5841 | 5856 | 5871 | 5886 | 5901 | 5916 | 5931 | 5946 | 5961 | 15 |
| 216 | 5976 | 5991 | 6006 | 6021 | 6036 | 6051 | 6066 | 6081 | 6095 | 6110 | 15 |
| 217 | 162·6125 | 6140 | 6154 | 6169 | 6183 | 6198 | 6213 | 6227 | 6242 | 6256 | 15 |
| 218 | 6271 | 6286 | 6300 | 6315 | 6329 | 6344 | 6359 | 6373 | 6388 | 6402 | 15 |
| 219 | 6417 | 6431 | 6446 | 6460 | 6475 | 6489 | 6503 | 6517 | 6532 | 6546 | 14 |
| 220 | 162·6560 | 6574 | 6588 | 6603 | 6617 | 6631 | 6645 | 6659 | 6674 | 6688 | 14 |
| 221 | 6702 | 6716 | 6730 | 6745 | 6759 | 6773 | 6787 | 6801 | 6815 | 6829 | 14 |
| 222 | 6843 | 6857 | 6871 | 6885 | 6899 | 6913 | 6927 | 6941 | 6954 | 6968 | 14 |
| 223 | 162·6982 | 6996 | 7010 | 7023 | 7037 | 7051 | 7065 | 7079 | 7092 | 7106 | 14 |
| 224 | 7120 | 7134 | 7147 | 7161 | 7174 | 7188 | 7202 | 7215 | 7229 | 7242 | 14 |
| 225 | 7256 | 7270 | 7283 | 7297 | 7310 | 7324 | 7338 | 7351 | 7365 | 7378 | 14 |
| 226 | 162·7392 | 7405 | 7419 | 7432 | 7446 | 7459 | 7472 | 7486 | 7499 | 7513 | 13 |
| 227 | 7526 | 7539 | 7553 | 7566 | 7580 | 7593 | 7606 | 7620 | 7633 | 7647 | 13 |
| 228 | 7660 | 7673 | 7687 | 7700 | 7714 | 7727 | 7740 | 7753 | 7767 | 7780 | 13 |
| 229 | 162·7793 | 7806 | 7819 | 7833 | 7846 | 7859 | 7872 | 7886 | 7899 | 7913 | 13 |
| 230 | 7926 | 7939 | 7952 | 7966 | 7979 | 7992 | 8005 | 8018 | 8032 | 8045 | 13 |
| 231 | 8058 | 8071 | 8084 | 8097 | 8110 | 8123 | 8136 | 8149 | 8162 | 8175 | 13 |
| 232 | 162·8188 | 8201 | 8214 | 8228 | 8241 | 8254 | 8267 | 8280 | 8293 | 8306 | 13 |
| 233 | 8319 | 8332 | 8345 | 8358 | 8371 | 8384 | 8397 | 8410 | 8423 | 8436 | 13 |
| 234 | 8449 | 8462 | 8475 | 8488 | 8501 | 8514 | 8527 | 8540 | 8553 | 8566 | 13 |
| 235 | 162·8579 | 8592 | 8605 | 8617 | 8630 | 8643 | 8656 | 8669 | 8682 | 8695 | 13 |
| 236 | 8708 | 8721 | 8734 | 8746 | 8759 | 8772 | 8785 | 8798 | 8810 | 8823 | 13 |
| 237 | 8836 | 8849 | 8862 | 8874 | 8887 | 8900 | 8913 | 8926 | 8938 | 8951 | 13 |
| 238 | 162·8964 | 8977 | 8990 | 9002 | 9015 | 9028 | 9041 | 9054 | 9066 | 9079 | 13 |
| 239 | 9092 | 9105 | 9117 | 9130 | 9142 | 9155 | 9168 | 9181 | 9193 | 9206 | 13 |
| 240 | 9219 | 9232 | 9244 | 9257 | 9269 | 9282 | 9295 | 9308 | 9320 | 9333 | 13 |
| 241 | 162·9346 | 9359 | 9371 | 9384 | 9396 | 9409 | 9422 | 9434 | 9447 | 9459 | 13 |
| 242 | 9472 | 9485 | 9497 | 9510 | 9522 | 9535 | 9548 | 9560 | 9573 | 9585 | 13 |
| 243 | 9598 | 9610 | 9623 | 9635 | 9648 | 9660 | 9673 | 9685 | 9698 | 9710 | 12 |
| 244 | 162·9723 | 9735 | 9748 | 9760 | 9773 | 9785 | 9797 | 9810 | 9822 | 9835 | 12 |
| 245 | 9847 | 9859 | 9872 | 9884 | 9897 | 9909 | 9921 | 9934 | 9946 | 9959 | 12 |
| 246 | 9971 | 9983 | 9996 | *0008 | *0021 | *0033 | *0045 | *0058 | *0070 | *0083 | 12 |
| 247 | 163·0095 | 0107 | 0119 | 0132 | 0144 | 0156 | 0168 | 0180 | 0193 | 0205 | 12 |
| 248 | 0217 | 0229 | 0241 | 0254 | 0266 | 0278 | 0290 | 0302 | 0315 | 0327 | 12 |
| 249 | 0339 | 0351 | 0363 | 0376 | 0388 | 0400 | 0412 | 0424 | 0437 | 0449 | 12 |

## XXVI. $T_v$ for Ogival-headed Projectiles (*continued*).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *f. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 250 | 163·0461 | 0473 | 0485 | 0497 | 0509 | 0521 | 0533 | 0545 | 0557 | 0569 | 12 |
| 251 | 0581 | 0593 | 0605 | 0617 | 0629 | 0641 | 0653 | 0665 | 0677 | 0689 | 12 |
| 252 | 0701 | 0713 | 0725 | 0736 | 0748 | 0760 | 0772 | 0784 | 0795 | 0807 | 12 |
| 253 | 163·0819 | 0831 | 0843 | 0854 | 0866 | 0878 | 0890 | 0902 | 0913 | 0925 | 12 |
| 254 | 0937 | 0949 | 0960 | 0972 | 0983 | 0995 | 1007 | 1018 | 1030 | 1041 | 12 |
| 255 | 1053 | 1065 | 1076 | 1088 | 1099 | 1111 | 1123 | 1134 | 1146 | 1157 | 12 |
| 256 | 163·1169 | 1180 | 1192 | 1203 | 1215 | 1226 | 1237 | 1249 | 1260 | 1272 | 11 |
| 257 | 1283 | 1294 | 1305 | 1317 | 1328 | 1339 | 1350 | 1362 | 1373 | 1385 | 11 |
| 258 | 1396 | 1407 | 1418 | 1430 | 1441 | 1452 | 1463 | 1474 | 1486 | 1497 | 11 |
| 259 | 163·1508 | 1519 | 1530 | 1542 | 1553 | 1564 | 1575 | 1586 | 1597 | 1608 | 11 |
| 260 | 1619 | 1630 | 1641 | 1652 | 1663 | 1674 | 1685 | 1696 | 1707 | 1718 | 11 |
| 261 | 1729 | 1740 | 1751 | 1762 | 1773 | 1784 | 1795 | 1806 | 1816 | 1827 | 11 |
| 262 | 163·1838 | 1849 | 1860 | 1870 | 1881 | 1892 | 1903 | 1914 | 1924 | 1935 | 11 |
| 263 | 1946 | 1957 | 1967 | 1978 | 1988 | 1999 | 2010 | 2020 | 2031 | 2041 | 11 |
| 264 | 2052 | 2062 | 2073 | 2083 | 2094 | 2104 | 2115 | 2125 | 2136 | 2146 | 10 |
| 265 | 163·2157 | 2167 | 2178 | 2188 | 2199 | 2209 | 2219 | 2230 | 2240 | 2251 | 10 |
| 266 | 2261 | 2271 | 2281 | 2292 | 2302 | 2312 | 2322 | 2332 | 2343 | 2353 | 10 |
| 267 | 2363 | 2373 | 2383 | 2394 | 2404 | 2414 | 2424 | 2434 | 2445 | 2455 | 10 |
| 268 | 163·2465 | 2475 | 2485 | 2496 | 2506 | 2516 | 2526 | 2536 | 2546 | 2556 | 10 |
| 269 | 2566 | 2576 | 2586 | 2596 | 2606 | 2616 | 2626 | 2636 | 2646 | 2656 | 10 |
| 270 | 2666 | 2676 | 2686 | 2695 | 2705 | 2715 | 2725 | 2735 | 2744 | 2754 | 10 |
| 271 | 163·2764 | 2774 | 2784 | 2793 | 2803 | 2813 | 2823 | 2833 | 2842 | 2852 | 10 |
| 272 | 2862 | 2872 | 2881 | 2891 | 2900 | 2910 | 2920 | 2929 | 2939 | 2948 | 10 |
| 273 | 2958 | 2968 | 2977 | 2987 | 2996 | 3006 | 3016 | 3025 | 3035 | 3044 | 10 |
| 274 | 163·3054 | 3063 | 3073 | 3082 | 3092 | 3101 | 3110 | 3120 | 3129 | 3139 | 9 |
| 275 | 3148 | 3157 | 3167 | 3176 | 3186 | 3195 | 3204 | 3214 | 3223 | 3233 | 9 |
| 276 | 3242 | 3251 | 3260 | 3270 | 3279 | 3288 | 3297 | 3306 | 3316 | 3325 | 9 |
| 277 | 163·3334 | 3343 | 3352 | 3362 | 3371 | 3380 | 3389 | 3398 | 3407 | 3416 | 9 |
| 278 | 3425 | 3434 | 3443 | 3452 | 3461 | 3470 | 3479 | 3488 | 3497 | 3506 | 9 |
| 279 | 3515 | 3524 | 3533 | 3542 | 3551 | 3560 | 3569 | 3578 | 3587 | 3596 | 9 |
| 280 | 163·3605 | 3614 | 3623 | 3631 | 3640 | 3649 | 3658 | 3667 | 3675 | 3684 | 9 |
| 281 | 3693 | 3702 | 3711 | 3719 | 3728 | 3737 | 3746 | 3755 | 3763 | 3772 | 9 |
| 282 | 3781 | 3790 | 3798 | 3807 | 3815 | 3824 | 3833 | 3842 | 3850 | 3859 | 9 |
| 283 | 163·3868 | 3877 | 3885 | 3894 | 3902 | 3911 | 3920 | 3928 | 3937 | 3945 | 9 |
| 284 | 3954 | 3962 | 3971 | 3979 | 3988 | 3996 | 4004 | 4013 | 4021 | 4030 | 8 |
| 285 | 4038 | 4046 | 4055 | 4063 | 4072 | 4080 | 4088 | 4097 | 4105 | 4114 | 8 |
| 286 | 163·4122 | 4130 | 4139 | 4147 | 4156 | 4164 | 4172 | 4180 | 4189 | 4197 | 8 |
| 287 | 4205 | 4213 | 4221 | 4230 | 4238 | 4246 | 4254 | 4262 | 4271 | 4279 | 8 |
| 288 | 4287 | 4295 | 4303 | 4312 | 4320 | 4328 | 4336 | 4344 | 4353 | 4361 | 8 |
| 289 | 163·4369 | 4377 | 4385 | 4393 | 4401 | 4409 | 4417 | 4425 | 4433 | 4441 | 8 |
| 290 | 4449 | 4457 | 4465 | 4473 | 4481 | 4489 | 4497 | 4505 | 4513 | 4521 | 8 |

XXVII. Values of $\frac{k}{g}$ for the Newtonian Law, and of $\frac{\mathfrak{K}}{g}$ for the Cubic Law of the Resistance of the Air to Spherical and Ogival-headed Projectiles ($\Pi = 1{\cdot}206$ kil.; or $\omega = 527$ grains; $g = 9{\cdot}809$ m. s.).

| | Spherical Projectiles. | | Ogival-headed Projectiles. | | | Spherical Projectiles. | | Ogival-headed Projectiles. | |
|---|---|---|---|---|---|---|---|---|---|
| | Newtonian Law | Cubic Law | Newtonian Law | Cubic Law | | Newtonian Law | Cubic Law | Newtonian Law | Cubic Law |
| b | $\frac{k}{g}$ | $\frac{\mathfrak{K}}{g}$ | $\frac{k}{g}$ | $\frac{\mathfrak{K}}{g}$ | b | $\frac{k}{g}$ | $\frac{\mathfrak{K}}{g}$ | $\frac{k}{g}$ | $\frac{\mathfrak{K}}{g}$ |
| *m. s.* | | | | | *m. s.* | | | | |
| 50 | | | 1·40 | 28·10 | 450 | 4·69 | 10·42 | 3·43 | 7·62 |
| 60 | | | 1·40 | 23·41 | 460 | 4·71 | 10·25 | 3·42 | 7·44 |
| 70 | | | 1·40 | 20·07 | 470 | 4·73 | 10·07 | 3·40 | 7·24 |
| 80 | | | 1·40 | 17·55 | 480 | 4·75 | 9·90 | 3·38 | 7·04 |
| 90 | | | 1·40 | 15·60 | 490 | 4·76 | 9·72 | 3·36 | 6·85 |
| 100 | | | 1·40 | 14·03 | 500 | 4·77 | 9·55 | 3·34 | 6·67 |
| 110 | | | 1·40 | 12·76 | 510 | 4·78 | 9·37 | 3·31 | 6·50 |
| 120 | | | 1·40 | 11·69 | 520 | 4·78 | 9·19 | 3·29 | 6·32 |
| 130 | | | 1·40 | 10·79 | 530 | 4·78 | 9·02 | 3·27 | 6·16 |
| 140 | | | 1·40 | 10·02 | 540 | 4·78 | 8·85 | 3·25 | 6·02 |
| 150 | | | 1·40 | 9·36 | 550 | 4·78 | 8·68 | 3·23 | 5·87 |
| 160 | | | 1·40 | 8·77 | 560 | 4·78 | 8·53 | 3·21 | 5·73 |
| 170 | | | 1·40 | 8·25 | 570 | 4·78 | 8·39 | 3·20 | 5·60 |
| 180 | | | 1·40 | 7·79 | 580 | 4·80 | 8·28 | 3·19 | 5·48 |
| 190 | | | 1·40 | 7·39 | 590 | 4·83 | 8·18 | 3·18 | 5·38 |
| 200 | | | 1·40 | 7·02 | 600 | 4·85 | 8·08 | 3·17 | 5·28 |
| 210 | | | 1·40 | 6·68 | 610 | 4·87 | 7·98 | 3·18 | 5·21 |
| 220 | | | 1·40 | 6·38 | 620 | 4·88 | 7·87 | 3·20 | 5·16 |
| 230 | | | 1·40 | 6·10 | 630 | 4·88 | 7·74 | 3·23 | 5·13 |
| 240 | | | 1·40 | 5·85 | 640 | 4·87 | 7·60 | 3·26 | 5·10 |
| 250 | 2·68 | 10·72 | 1·41 | 5·62 | 650 | 4·85 | 7·46 | 3·30 | 5·07 |
| 260 | 2·79 | 10·72 | 1·46 | 5·60 | 660 | 4·83 | 7·32 | 3·33 | 5·05 |
| 270 | 2·89 | 10·72 | 1·51 | 5·60 | 670 | 4·82 | 7·19 | 3·36 | 5·01 |
| 280 | 3·00 | 10·72 | 1·57 | 5·60 | 680 | 4·80 | 7·07 | 3·37 | 4·95 |
| 290 | 3·11 | 10·72 | 1·62 | 5·60 | 690 | 4·79 | 6·94 | 3·35 | 4·86 |
| 300 | 3·23 | 10·75 | 1·68 | 5·60 | 700 | 4·78 | 6·82 | 3·32 | 4·75 |
| 310 | 3·39 | 10·93 | 1·75 | 5·66 | 710 | | | 3·28 | 4·62 |
| 320 | 3·63 | 10·35 | 2·12 | 6·64 | 720 | | | 3·23 | 4·49 |
| 330 | 3·84 | 11·63 | 2·59 | 7·83 | 730 | | | 3·18 | 4·36 |
| 340 | 4·01 | 11·79 | 2·79 | 8·21 | 740 | | | 3·14 | 4·24 |
| 350 | 4·15 | 11·86 | 2·91 | 8·34 | 750 | | | 3·10 | 4·13 |
| 360 | 4·27 | 11·87 | 3·00 | 8·34 | 760 | | | 3·07 | 4·04 |
| 370 | 4·36 | 11·79 | 3·09 | 8·34 | 770 | | | 3·07 | 3·99 |
| 380 | 4·42 | 11·64 | 3·17 | 8·34 | 780 | | | 3·08 | 3·95 |
| 390 | 4·47 | 11·45 | 3·25 | 8·34 | 790 | | | 3·10 | 3·92 |
| 400 | 4·50 | 11·24 | 3·32 | 8·30 | 800 | | | 3·13 | 3·91 |
| 410 | 4·54 | 11·08 | 3·37 | 8·21 | 810 | | | 3·17 | 3·91 |
| 420 | 4·59 | 10·92 | 3·40 | 8·10 | 820 | | | 3·20 | 3·91 |
| 430 | 4·63 | 10·76 | 3·42 | 7·96 | 830 | | | 3·24 | 3·90 |
| 440 | 4·66 | 10·59 | 3·43 | 7·80 | 840 | | | 3·28 | 3·90 |

Approximate Laws of the Resistance of the Air to the Motion of Projectiles (*French Measures*).

$\Pi = 1{\cdot}206$ kil.; $\omega = 527$ grains; $g = 9{\cdot}809$ m. s.

## XXVIII. Spherical Projectiles.

| | | | |
|---|---|---|---|
| $\mathfrak{v} > 396$ m. s., | $\rho \propto \mathfrak{v}^2$, | $\frac{\mathfrak{k}}{g} = 4{\cdot}761$, | $\log \frac{\mathfrak{k}}{g} = 0{\cdot}67774$, |
| $\mathfrak{v} < 396 > 335$ m. s., | $\rho \propto \mathfrak{v}^3$, | $\frac{\mathfrak{K}}{g} = 11{\cdot}703$, | $\log \frac{\mathfrak{K}}{g} = 1{\cdot}06830$, |
| $\mathfrak{v} < 335 > 305$ m. s., | $\rho \propto \mathfrak{v}^4$, | $\frac{\mathfrak{h}}{g} = 35{\cdot}350$, | $\log \frac{\mathfrak{h}}{g} = 1{\cdot}54839$, |
| $\mathfrak{v} < 305 > 256$ m. s., | $\rho \propto \mathfrak{v}^3$, | $\frac{\mathfrak{K}}{g} = 10{\cdot}706$, | $\log \frac{\mathfrak{K}}{g} = 1{\cdot}02963$, |
| $\mathfrak{v} < 256$ m. s. , | $\rho \propto \mathfrak{v}^2$, | $\frac{\mathfrak{k}}{g} = 2{\cdot}744$, | $\log \frac{\mathfrak{k}}{g} = 0{\cdot}43833$. |

## XXIX. Ogival-headed Projectiles.

| | | | |
|---|---|---|---|
| $\mathfrak{v} > 396$ m. s., | $\rho \propto \mathfrak{v}^2$, | $\frac{\mathfrak{k}}{g} = 3{\cdot}275$, | $\log \frac{\mathfrak{k}}{g} = 0{\cdot}51518$, |
| $\mathfrak{v} < 396 > 335$ m. s., | $\rho \propto \mathfrak{v}^3$, | $\frac{\mathfrak{K}}{g} = 8{\cdot}302$, | $\log \frac{\mathfrak{K}}{g} = 0{\cdot}91916$, |
| $\mathfrak{v} < 335 > 305$ m. s., | $\rho \propto \mathfrak{v}^6$, | $\frac{\mathfrak{L}}{g} = 206{\cdot}92$, | $\log \frac{\mathfrak{L}}{g} = 2{\cdot}31580$, |
| $\mathfrak{v} < 305 > 250$ m. s., | $\rho \propto \mathfrak{v}^3$, | $\frac{\mathfrak{K}}{g} = 5{\cdot}600$, | $\log \frac{\mathfrak{K}}{g} = 0{\cdot}74822$, |
| $\mathfrak{v} < 250$ m. s. , | $\rho \propto \mathfrak{v}^2$, | $\frac{\mathfrak{k}}{g} = 1{\cdot}403$, | $\log \frac{\mathfrak{k}}{g} = 0{\cdot}14710$. |

XXX. $\mathfrak{L}_b$ for Spherical Projectiles ($\Pi = 1{\cdot}206$ kil. or $\omega = 527$ grains).

| b | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *m. s.* | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | + |
| 12 | 68 | 376 | 682 | 986 | 1288 | 1586 | 1881 | 2175 | 2466 | 2755 | 299 |
| 13 | 3042 | 3327 | 3610 | 3891 | 4170 | 4447 | 4721 | 4993 | 5263 | 5531 | 277 |
| 14 | 5798 | 6062 | 6325 | 6586 | 6845 | 7102 | 7358 | 7612 | 7864 | 8114 | 257 |
| 15 | 8363 | 8610 | 8856 | 9100 | 9342 | 9582 | 9821 | *0058 | *0294 | *0528 | 241 |
| 16 | 1 0761 | 0993 | 1223 | 1452 | 1680 | 1906 | 2131 | 2355 | 2577 | 2799 | 226 |
| 17 | 3018 | 3237 | 3454 | 3670 | 3884 | 4097 | 4309 | 4519 | 4728 | 4936 | 213 |
| 18 | 5142 | 5348 | 5552 | 5755 | 5957 | 6158 | 6357 | 6556 | 6753 | 6951 | 201 |
| 19 | 7149 | 7343 | 7537 | 7730 | 7922 | 8113 | 8304 | 8494 | 8683 | 8871 | 191 |
| 20 | 9059 | 9245 | 9430 | 9613 | 9795 | 9976 | *0156 | *0336 | *0514 | *0692 | 182 |
| 21 | 2 0868 | 1044 | 1219 | 1393 | 1567 | 1740 | 1913 | 2085 | 2257 | 2427 | 173 |
| 22 | 2597 | 2766 | 2934 | 3101 | 3267 | 3433 | 3598 | 3762 | 3926 | 4088 | 166 |
| 23 | 4250 | 4411 | 4571 | 4731 | 4890 | 5048 | 5206 | 5363 | 5519 | 5675 | 158 |
| 24 | 5830 | 5985 | 6139 | 6293 | 6446 | 6598 | 6750 | 6900 | 7050 | 7199 | 152 |
| 25 | 7348 | 7497 | 7645 | 7792 | 7939 | 8085 | 8231 | 8376 | 8521 | 8665 | 146 |
| 26 | 2 8808 | 8948 | 9087 | 9224 | 9361 | 9496 | 9631 | 9764 | 9897 | *0029 | 136 |
| 27 | 3 0161 | 0291 | 0420 | 0547 | 0674 | 0799 | 0926 | 1049 | 1171 | 1293 | 126 |
| 28 | 1414 | 1535 | 1655 | 1774 | 1893 | 2011 | 2128 | 2244 | 2359 | 2473 | 118 |
| 29 | 2587 | 2700 | 2812 | 2923 | 3034 | 3144 | 3253 | 3361 | 3469 | 3576 | 110 |
| 30 | 3682 | 3787 | 3892 | 3995 | 4098 | 4200 | 4301 | 4401 | 4500 | 4598 | 102 |
| 31 | 3 4695 | 4791 | 4887 | 4982 | 5076 | 5168 | 5260 | 5350 | 5439 | 5528 | 93 |
| 32 | 5616 | 5703 | 5790 | 5876 | 5961 | 6046 | 6131 | 6215 | 6298 | 6377 | 85 |
| 33 | 6456 | 6536 | 6615 | 6694 | 6772 | 6850 | 6927 | 7004 | 7080 | 7155 | 78 |
| 34 | 7230 | 7305 | 7379 | 7453 | 7526 | 7599 | 7671 | 7743 | 7814 | 7885 | 73 |
| 35 | 7955 | 8025 | 8094 | 8163 | 8232 | 8300 | 8368 | 8436 | 8503 | 8570 | 68 |
| 36 | 3 8636 | 8702 | 8768 | 8834 | 8899 | 8964 | 9028 | 9092 | 9156 | 9220 | 65 |
| 37 | 9283 | 9347 | 9410 | 9473 | 9535 | 9598 | 9660 | 9722 | 9784 | 9845 | 62 |
| 38 | 9906 | 9966 | *0026 | *0086 | *0145 | *0204 | *0263 | *0323 | *0382 | *0441 | 59 |
| 39 | 4 0500 | 0559 | 0617 | 0675 | 0733 | 0791 | 0848 | 0905 | 0962 | 1019 | 58 |
| 40 | 1076 | 1133 | 1190 | 1246 | 1302 | 1358 | 1413 | 1468 | 1523 | 1578 | 56 |
| 41 | 4 1632 | 1686 | 1740 | 1794 | 1848 | 1902 | 1955 | 2009 | 2063 | 2117 | 54 |
| 42 | 2171 | 2224 | 2277 | 2330 | 2382 | 2434 | 2485 | 2537 | 2588 | 2640 | 52 |
| 43 | 2691 | 2743 | 2794 | 2845 | 2896 | 2947 | 2997 | 3047 | 3096 | 3146 | 51 |
| 44 | 3195 | 3245 | 3294 | 3344 | 3393 | 3443 | 3492 | 3542 | 3591 | 3640 | 49 |
| 45 | 3688 | 3736 | 3784 | 3832 | 3879 | 3926 | 3973 | 4021 | 4068 | 4115 | 47 |
| 46 | 4 4162 | 4210 | 4257 | 4304 | 4351 | 4398 | 4444 | 4490 | 4536 | 4582 | 46 |
| 47 | 4628 | 4674 | 4719 | 4764 | 4809 | 4854 | 4899 | 4944 | 4989 | 5034 | 45 |
| 48 | 5079 | 5124 | 5169 | 5214 | 5258 | 5302 | 5346 | 5390 | 5434 | 5478 | 44 |
| 49 | 5521 | 5565 | 5609 | 5653 | 5696 | 5739 | 5782 | 5825 | 5868 | 5911 | 43 |
| 50 | 5954 | 5997 | 6039 | 6082 | 6125 | 6168 | 6210 | 6252 | 6294 | 6336 | 42 |
| 51 | 4 6378 | 6420 | 6462 | 6504 | 6545 | 6586 | 6627 | 6668 | 6708 | 6749 | 41 |
| 52 | 6789 | 6830 | 6870 | 6911 | 6952 | 6993 | 7033 | 7074 | 7114 | 7155 | 41 |
| 53 | 7195 | 7236 | 7276 | 7316 | 7356 | 7396 | 7436 | 7476 | 7516 | 7556 | 40 |
| 54 | 7595 | 7635 | 7674 | 7713 | 7752 | 7792 | 7831 | 7870 | 7909 | 7948 | 39 |
| 55 | 7987 | 8026 | 8064 | 8103 | 8141 | 8180 | 8218 | 8257 | 8295 | 8333 | 38 |
| 56 | 4 8371 | 8409 | 8447 | 8485 | 8523 | 8561 | 8599 | 8637 | 8674 | 8712 | 38 |
| 57 | 8749 | 8786 | 8823 | 8861 | 8898 | 8935 | 8972 | 9009 | 9046 | 9083 | 37 |
| 58 | 9119 | 9156 | 9192 | 9229 | 9265 | 9301 | 9337 | 9373 | 9409 | 9445 | 36 |
| 59 | 9481 | 9517 | 9552 | 9588 | 9623 | 9659 | 9694 | 9730 | 9765 | 9800 | 35 |
| 60 | 9835 | 9870 | 9905 | 9940 | 9975 | *0010 | *0045 | *0080 | *0114 | *0148 | 35 |
| 61 | 5 0182 | 0217 | 0251 | 0285 | 0319 | 0353 | 0387 | 0421 | 0455 | 0489 | 34 |
| 62 | 0523 | 0557 | 0590 | 0624 | 0657 | 0690 | 0723 | 0757 | 0790 | 0823 | 33 |
| 63 | 0856 | 0889 | 0922 | 0955 | 0988 | 1021 | 1054 | 1087 | 1120 | 1153 | 33 |
| 64 | 1186 | 1219 | 1252 | 1285 | 1317 | 1350 | 1382 | 1415 | 1447 | 1479 | 33 |
| 65 | 1511 | 1544 | 1576 | 1608 | 1640 | 1673 | 1705 | 1737 | 1769 | 1801 | 32 |
| 66 | 5 1833 | 1865 | 1897 | 1929 | 1961 | 1993 | 2024 | 2056 | 2088 | 2120 | 32 |
| 67 | 2151 | 2183 | 2214 | 2246 | 2277 | 2309 | 2340 | 2371 | 2402 | 2434 | 31 |
| 68 | 2465 | 2496 | 2527 | 2558 | 2589 | 2620 | 2651 | 2682 | 2713 | 2744 | 31 |
| 69 | 2775 | 2806 | 2837 | 2868 | 2899 | 2930 | 2960 | 2991 | 3021 | 3052 | 31 |

## XXXI. $\mathfrak{T}_v$ for Spherical Projectiles ($\Pi = 1{\cdot}205$ kil. or $\omega = 527$ grains).

| $v$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *m. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 12 | 55·9 | 58·5 | 61·1 | 63·6 | 66·1 | 68·5 | 70·8 | 73·1 | 75·4 | 77·6 | 2·4 |
| 13 | 79·8 | 82·0 | 84·2 | 86·4 | 88·5 | 90 6 | 92·6 | 94·6 | 96·6 | 98·5 | 2·1 |
| 14 | 100·4 | 102·3 | 104·1 | 105·9 | 107·7 | 109·5 | 111·2 | 113·0 | 114·7 | 116·4 | 1·8 |
| 15 | 118·0 | 119·7 | 121·3 | 122·9 | 124·5 | 126·1 | 127·6 | 129·1 | 130·6 | 132·1 | 1·6 |
| 16 | 133·5 | 135·0 | 136·4 | 137·8 | 139·2 | 140·6 | 142·0 | 143·4 | 144·7 | 146·0 | 1·4 |
| 17 | 147·2 | 148·5 | 149·7 | 151·0 | 152·2 | 153·4 | 154·6 | 155·8 | 156·9 | 158·1 | 1·2 |
| 18 | 159·2 | 160·4 | 161·5 | 162·6 | 163·7 | 164·9 | 166·0 | 167·1 | 168·2 | 169·2 | 1·1 |
| 19 | 170·2 | 171·2 | 172·2 | 173·2 | 174·2 | 175·2 | 176·2 | 177·1 | 178·1 | 179·0 | 1·0 |
| 20 | 180·0 | 180·9 | 181·8 | 182·7 | 183·6 | 184·5 | 185·4 | 186·3 | 187·1 | 188·0 | 0·9 |
| 21 | 1 88·83 | 89·66 | 90·49 | 91·31 | 92·13 | 92·94 | 93·75 | 94·54 | 95·33 | 96·10 | ·81 |
| 22 | 96·87 | 97·63 | 98·39 | 99·14 | 99·88 | *00·62 | *01·35 | *02·08 | *02 81 | *03·52 | ·74 |
| 23 | 2 04·23 | 04·92 | 05·61 | 06·29 | 06·97 | 07·65 | 08·32 | 08·99 | 09·65 | 10·31 | ·68 |
| 24 | 10·96 | 11·61 | 12·25 | 12·88 | 13·51 | 14·13 | 14·75 | 15·36 | 15·96 | 16·56 | ·62 |
| 25 | 17·15 | 17·74 | 18·33 | 18·91 | 19·49 | 20·07 | 20·64 | 21·21 | 21·77 | 22·31 | ·57 |
| 26 | 2 22·84 | 23·38 | 23·92 | 24·45 | 24·97 | 25·48 | 25·99 | 26·49 | 26·99 | 27·48 | ·52 |
| 27 | 27·96 | 28·44 | 28·91 | 29·38 | 29·85 | 30·31 | 30·77 | 31·22 | 31·67 | 32·11 | ·46 |
| 28 | 32·55 | 32·98 | 33·40 | 33·82 | 34·24 | 34·65 | 35·06 | 35·46 | 35·86 | 36·26 | ·41 |
| 29 | 36·65 | 37·04 | 37·43 | 37·81 | 38·19 | 38·56 | 38·93 | 39·29 | 39·65 | 40·01 | ·37 |
| 30 | 40·36 | 40·71 | 41·05 | 41·39 | 41·73 | 42·07 | 42·41 | 42·74 | 43·06 | 43·37 | ·33 |
| 31 | 2 43·68 | 43·99 | 44·29 | 44·60 | 44·90 | 45·20 | 45·49 | 45·78 | 46·06 | 46·34 | ·30 |
| 32 | 46·62 | 46·89 | 47·15 | 47·42 | 47·68 | 47·94 | 48·20 | 48·46 | 48·71 | 48·96 | ·26 |
| 33 | 49·20 | 49·44 | 49·68 | 49·92 | 50·15 | 50·38 | 50·61 | 50·84 | 51·07 | 51·29 | ·23 |
| 34 | 51·51 | 51·73 | 51·95 | 52·17 | 52·38 | 52·59 | 52·80 | 53·01 | 53·21 | 53·41 | ·21 |
| 35 | 53·61 | 53·81 | 54·01 | 54·21 | 54·40 | 54·60 | 54·79 | 54·98 | 55·17 | 55·36 | ·19 |
| 36 | 2 55·54 | 55·72 | 55·90 | 56·08 | 56·26 | 56·44 | 56·61 | 56·79 | 56·96 | 57·13 | ·18 |
| 37 | 57·30 | 57·47 | 57·64 | 57·81 | 57·98 | 58·15 | 58·31 | 58·48 | 58·64 | 58·80 | ·17 |
| 38 | 58·96 | 59·12 | 59·28 | 59·44 | 59·59 | 59·75 | 59·90 | 60·05 | 60·20 | 60·35 | ·15 |
| 39 | 60·50 | 60·65 | 60·80 | 60·95 | 61·10 | 61·25 | 61·39 | 61·53 | 61·67 | 61·82 | ·15 |
| 40 | 61·96 | 62·10 | 62·24 | 62·38 | 62·52 | 62·66 | 62·80 | 62·94 | 63·07 | 63·21 | ·14 |
| 41 | 2 63·34 | 63·48 | 63·61 | 63·74 | 63·87 | 64·00 | 64·12 | 64·25 | 64·38 | 64·51 | ·13 |
| 42 | 64·63 | 64·76 | 64·88 | 65·01 | 65·13 | 65·26 | 65·38 | 65·50 | 65·62 | 65·74 | ·12 |
| 43 | 65·86 | 65·98 | 66·10 | 66·22 | 66·33 | 66·45 | 66·56 | 66·68 | 66·79 | 66·91 | ·12 |
| 44 | 67·02 | 67·14 | 67·25 | 67·36 | 67·47 | 67·58 | 67·69 | 67·80 | 67·91 | 68·02 | ·11 |
| 45 | 68·13 | 68·24 | 68·34 | 68·45 | 68·55 | 68·66 | 68·76 | 68·87 | 68·97 | 69·07 | ·10 |
| 46 | 2 69·17 | 69·28 | 69·38 | 69·48 | 69·58 | 69·68 | 69·78 | 69·88 | 69·98 | 70·08 | ·10 |
| 47 | 70·17 | 70·27 | 70·36 | 70·46 | 70·56 | 70·65 | 70·75 | 70·84 | 70·94 | 71·03 | ·10 |
| 48 | 27 1·123 | 1·216 | 1·308 | 1·400 | 1·492 | 1·583 | 1·674 | 1·765 | 1·855 | 1·945 | ·092 |
| 49 | 2·034 | 2·123 | 2·211 | 2·299 | 2·387 | 2·474 | 2·561 | 2·648 | 2·734 | 2·820 | ·087 |
| 50 | 2·905 | 2·990 | 3·075 | 3·160 | 3·244 | 3·328 | 3·411 | 3·495 | 3·578 | 3·661 | ·084 |
| 51 | 27 3·743 | 3·825 | 3·907 | 3·988 | 4·069 | 4·150 | 4·230 | 4·310 | 4·389 | 4·468 | ·081 |
| 52 | 4·547 | 4·625 | 4·703 | 4·781 | 4·859 | 4·936 | 5·013 | 5·090 | 5·167 | 5·243 | ·077 |
| 53 | 5·319 | 5·395 | 5·471 | 5·546 | 5·621 | 5·696 | 5·770 | 5·844 | 5·917 | 5 991 | ·075 |
| 54 | 6·064 | 6·137 | 6·209 | 6·282 | 6·354 | 6·426 | 6·498 | 6·570 | 6·640 | 6·712 | ·072 |
| 55 | 6·783 | 6·854 | 6·924 | 6·994 | 7·063 | 7·133 | 7·202 | 7·271 | 7·340 | 7·409 | ·070 |
| 56 | 27 7·477 | 7·545 | 7·613 | 7·681 | 7·748 | 7·815 | 7·882 | 7·948 | 8·014 | 8·080 | ·067 |
| 57 | 8·145 | 8·210 | 8·275 | 8·340 | 8·405 | 8·471 | 8·534 | 8·598 | 8·662 | 8·726 | ·065 |
| 58 | 8·789 | 8·852 | 8·915 | 8·978 | 9·040 | 9·102 | 9·163 | 9·225 | 9·286 | 9·347 | ·062 |
| 59 | 9·408 | 9·469 | 9·529 | 9·589 | 9·648 | 9·708 | 9·767 | 9·826 | 9·885 | 9·944 | ·060 |
| 60 | 28 0·003 | 0·061 | 0·119 | 0·177 | 0·234 | 0·292 | 0·349 | 0·406 | 0·463 | 0·520 | ·058 |
| 61 | 28 0·577 | 0·633 | 0·689 | 0·745 | 0·800 | 0·855 | 0·910 | 0·965 | 1·020 | 1·075 | ·055 |
| 62 | 1·129 | 1·184 | 1·238 | 1·292 | 1·346 | 1·400 | 1·453 | 1·506 | 1·559 | 1·612 | ·054 |
| 63 | 1·665 | 1·718 | 1·770 | 1·822 | 1·874 | 1·926 | 1·977 | 2·029 | 2·080 | 2·132 | ·052 |
| 64 | 2·183 | 2·234 | 2·285 | 2·336 | 2·386 | 2·437 | 2·487 | 2·537 | 2·587 | 2·637 | ·050 |
| 65 | 2·687 | 2·737 | 2·786 | 2·836 | 2·885 | 2·934 | 2·983 | 3·032 | 3·081 | 3·130 | ·049 |
| 66 | 28 3·178 | 3·226 | 3·274 | 3·322 | 3·370 | 3·418 | 3·466 | 3·514 | 3·561 | 3·609 | ·048 |
| 67 | 3·656 | 3·704 | 3·751 | 3·798 | 3·845 | 3·892 | 3·938 | 3·984 | 4·030 | 4·076 | ·047 |
| 68 | 4·122 | 4·168 | 4·213 | 4·259 | 4·304 | 4·349 | 4·394 | 4·439 | 4·484 | 4·529 | ·045 |
| 69 | 4·574 | 4·619 | 4·663 | 4·708 | 4·752 | 4·796 | 4·840 | 4·884 | 4·928 | 4·972 | ·044 |

## XXXII. $\mathfrak{D}_t$ for Ogival-headed Projectiles
(Π = 1·206 kil., or ω = 527 grains).

| b | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *m. s.* | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | + |
| 5 | 4 0083 | 1516 | 2923 | 4307 | 5666 | 7002 | 8312 | 9596 | *0857 | *2101 | 1335 |
| 6 | 5 3323 | 4524 | 5706 | 6871 | 8018 | 9148 | *0260 | *1355 | *2432 | *3491 | 1130 |
| 7 | 6 4529 | 5558 | 6573 | 7575 | 8564 | 9536 | *0499 | *1448 | *2385 | *3312 | 966 |
| 8 | 7 4226 | 5128 | 6020 | 6899 | 7770 | 8631 | 9484 | *0328 | *1159 | *1977 | 851 |
| 9 | 8 2785 | 3586 | 4381 | 5168 | 5946 | 6715 | 7476 | 8228 | 8975 | 9714 | 770 |
| 10 | 9 0443 | 1169 | 1885 | 2593 | 3292 | 3986 | 4677 | 5358 | 6035 | 6703 | 696 |
| 11 | 9 7363 | 8022 | 8673 | 9319 | 9961 | *0594 | *1222 | *1847 | *2466 | *3077 | 635 |
| 12 | 10 3688 | 4291 | 4889 | 5482 | 6071 | 6651 | 7232 | 7808 | 8379 | 8946 | 584 |
| 13 | 10 9504 | *0058 | *0612 | *1162 | *1707 | *2243 | *2779 | *3311 | *3843 | *4366 | 540 |
| 14 | 11 4889 | 5403 | 5918 | 6424 | 6929 | 7430 | 7931 | 8428 | 8921 | 9409 | 502 |
| 15 | 11 9897 | *0384 | *0864 | *1338 | *1809 | *2279 | *2745 | *3211 | *3673 | *4130 | 470 |
| 16 | 12 4587 | 5040 | 5488 | 5937 | 6381 | 6825 | 7264 | 7699 | 8135 | 8565 | 442 |
| 17 | 12 8996 | 9423 | 9845 | *0267 | *0689 | *1102 | *1515 | *1928 | *2337 | *2742 | 416 |
| 18 | 13 3146 | 3550 | 3951 | 4351 | 4746 | 5142 | 5533 | 5924 | 6311 | 6694 | 394 |
| 19 | 13 7076 | 7459 | 7837 | 8215 | 8593 | 8966 | 9340 | 9709 | *0079 | *0443 | 374 |
| 20 | 14 0808 | 1169 | 1529 | 1890 | 2246 | 2602 | 2958 | 3310 | 3657 | 4004 | 355 |
| 21 | 14 4351 | 4694 | 5037 | 5380 | 5723 | 6061 | 6396 | 6734 | 7068 | 7398 | 339 |
| 22 | 14 7728 | 8057 | 8383 | 8712 | 9038 | 9358 | 9679 | *0000 | *0321 | *0638 | 323 |
| 23 | 15 0959 | 1275 | 1592 | 1904 | 2212 | 2524 | 2831 | 3139 | 3442 | 3750 | 310 |
| 24 | 15 4053 | 4357 | 4660 | 4959 | 5254 | 5552 | 5847 | 6142 | 6436 | 6726 | 297 |
| 25 | 15 7016 | 7306 | 7597 | 7882 | 8168 | 8449 | 8726 | 9003 | 9276 | 9548 | 281 |
| 26 | 15 9821 | *0089 | *0357 | *0621 | *0880 | *1140 | *1399 | *1654 | *1909 | *2160 | 260 |
| 27 | 16 2410 | 2661 | 2911 | 3156 | 3400 | 3644 | 3886 | 4124 | 4358 | 4591 | 242 |
| 28 | 16 4819 | 5052 | 5281 | 5509 | 5738 | 5962 | 6184 | 6406 | 6626 | 6846 | 225 |
| 29 | 16 7066 | 7281 | 7492 | 7707 | 7918 | 8129 | 8336 | 8543 | 8749 | 8956 | 210 |
| 30 | 16 9158 | 9360 | 9563 | 9760 | 9956 | *0152 | *0345 | *0538 | *0732 | *0921 | 196 |
| 31 | 17 1110 | 1299 | 1484 | 1664 | 1840 | 2015 | 2187 | 2354 | 2521 | 2679 | 174 |
| 32 | 17 2833 | 2978 | 3123 | 3260 | 3396 | 3528 | 3655 | 3783 | 3906 | 4029 | 133 |
| 33 | 17 4148 | 4267 | 4384 | 4499 | 4613 | 4725 | 4836 | 4947 | 5057 | 5164 | 113 |
| 34 | 17 5271 | 5377 | 5482 | 5586 | 5690 | 5793 | 5895 | 5996 | 6098 | 6199 | 103 |
| 35 | 17 6299 | 6399 | 6498 | 6595 | 6693 | 6790 | 6888 | 6984 | 7079 | 7175 | 97 |
| 36 | 17 7269 | 7363 | 7457 | 7550 | 7642 | 7734 | 7825 | 7916 | 8007 | 8098 | 92 |
| 37 | 17 8188 | 8277 | 8365 | 8453 | 8540 | 8627 | 8714 | 8800 | 8886 | 8972 | 87 |
| 38 | 17 9057 | 9141 | 9225 | 9309 | 9392 | 9475 | 9557 | 9639 | 9721 | 9801 | 83 |
| 39 | 17 9882 | 9962 | *0041 | *0120 | *0200 | *0278 | *0356 | *0434 | *0512 | *0589 | 79 |
| 40 | 18 0666 | 0743 | 0819 | 0895 | 0971 | 1047 | 1122 | 1197 | 1271 | 1346 | 76 |
| 41 | 18 1419 | 1493 | 1566 | 1640 | 1713 | 1786 | 1858 | 1931 | 2003 | 2074 | 73 |
| 42 | 18 2146 | 2217 | 2288 | 2359 | 2429 | 2500 | 2570 | 2640 | 2710 | 2779 | 70 |
| 43 | 18 2849 | 2918 | 2987 | 3055 | 3124 | 3192 | 3260 | 3328 | 3396 | 3464 | 68 |
| 44 | 18 3532 | 3599 | 3666 | 3733 | 3800 | 3867 | 3934 | 4001 | 4067 | 4133 | 67 |
| 45 | 18 4199 | 4265 | 4331 | 4397 | 4463 | 4528 | 4593 | 4658 | 4723 | 4788 | 65 |

## XXXII. $\mathfrak{D}_t$ for Ogival-headed Projectiles (*continued*).

| t | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *m. s.* | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | Metres | + |
| 46 | 18 4853 | 4918 | 4983 | 5048 | 5112 | 5176 | 5240 | 5304 | 5368 | 5432 | 64 |
| 47 | 5495 | 5559 | 5623 | 5687 | 5751 | 5815 | 5878 | 5941 | 6004 | 6067 | 64 |
| 48 | 6130 | 6193 | 6255 | 6318 | 6380 | 6443 | 6505 | 6568 | 6630 | 6692 | 62 |
| 49 | 6754 | 6816 | 6878 | 6940 | 7001 | 7063 | 7124 | 7185 | 7246 | 7308 | 62 |
| 50 | 7369 | 7430 | 7491 | 7552 | 7613 | 7674 | 7734 | 7795 | 7855 | 7916 | 61 |
| 51 | 18 7976 | 8037 | 8097 | 8157 | 8217 | 8277 | 8337 | 8397 | 8457 | 8517 | 60 |
| 52 | 8576 | 8636 | 8695 | 8755 | 8814 | 8874 | 8933 | 8992 | 9051 | 9110 | 59 |
| 53 | 9169 | 9228 | 9287 | 9346 | 9404 | 9463 | 9521 | 9580 | 9638 | 9697 | 59 |
| 54 | 9755 | 9813 | 9871 | 9929 | 9986 | *0044 | *0102 | *0160 | *0217 | *0275 | 58 |
| 55 | 19 0332 | 0390 | 0447 | 0504 | 0561 | 0618 | 0675 | 0732 | 0789 | 0846 | 57 |
| 56 | 19 0903 | 0960 | 1016 | 1073 | 1129 | 1186 | 1242 | 1298 | 1354 | 1410 | 56 |
| 57 | 1466 | 1522 | 1578 | 1634 | 1689 | 1745 | 1800 | 1856 | 1911 | 1967 | 56 |
| 58 | 2022 | 2077 | 2132 | 2187 | 2242 | 2297 | 2352 | 2407 | 2462 | 2517 | 55 |
| 59 | 2571 | 2626 | 2680 | 2734 | 2788 | 2843 | 2897 | 2951 | 3005 | 3059 | 54 |
| 60 | 3113 | 3167 | 3220 | 3273 | 3326 | 3379 | 3432 | 3485 | 3538 | 3591 | 53 |
| 61 | 19 3643 | 3696 | 3748 | 3801 | 3853 | 3905 | 3957 | 4009 | 4061 | 4113 | 52 |
| 62 | 4164 | 4216 | 4267 | 4318 | 4369 | 4420 | 4470 | 4521 | 4571 | 4622 | 51 |
| 63 | 4672 | 4722 | 4772 | 4822 | 4872 | 4922 | 4971 | 5020 | 5069 | 5118 | 50 |
| 64 | 5167 | 5215 | 5264 | 5312 | 5361 | 5409 | 5458 | 5506 | 5554 | 5601 | 48 |
| 65 | 5648 | 5696 | 5743 | 5791 | 5838 | 5885 | 5932 | 5979 | 6026 | 6072 | 47 |
| 66 | 19 6119 | 6165 | 6211 | 6257 | 6303 | 6349 | 6395 | 6440 | 6486 | 6531 | 46 |
| 67 | 6576 | 6622 | 6667 | 6712 | 6757 | 6802 | 6847 | 6892 | 6937 | 6982 | 45 |
| 68 | 7026 | 7071 | 7115 | 7160 | 7204 | 7248 | 7292 | 7336 | 7380 | 7424 | 44 |
| 69 | 7468 | 7512 | 7555 | 7599 | 7643 | 7687 | 7731 | 7775 | 7819 | 7863 | 44 |
| 70 | 7907 | 7951 | 7995 | 8039 | 8082 | 8126 | 8170 | 8214 | 8257 | 8301 | 44 |
| 71 | 19 8345 | 8389 | 8432 | 8476 | 8520 | 8564 | 8607 | 8651 | 8695 | 8739 | 44 |
| 72 | 8782 | 8826 | 8870 | 8914 | 8958 | 9002 | 9046 | 9090 | 9134 | 9178 | 44 |
| 73 | 9222 | 9266 | 9309 | 9353 | 9397 | 9441 | 9485 | 9529 | 9573 | 9617 | 44 |
| 74 | 9661 | 9705 | 9749 | 9793 | 9836 | 9880 | 9924 | 9968 | *0012 | *0056 | 44 |
| 75 | 20 0100 | 0144 | 0188 | 0232 | 0275 | 0319 | 0363 | 0407 | 0451 | 0495 | 44 |
| 76 | 20 0539 | 0583 | 0626 | 0670 | 0713 | 0757 | 0800 | 0844 | 0887 | 0930 | 43 |
| 77 | 0973 | 1016 | 1059 | 1102 | 1145 | 1188 | 1230 | 1273 | 1315 | 1358 | 43 |
| 78 | 1400 | 1443 | 1485 | 1527 | 1569 | 1611 | 1653 | 1695 | 1737 | 1779 | 42 |
| 79 | 1820 | 1862 | 1904 | 1946 | 1987 | 2028 | 2069 | 2110 | 2151 | 2192 | 41 |
| 80 | 2233 | 2274 | 2314 | 2355 | 2395 | 2435 | 2475 | 2515 | 2555 | 2595 | 40 |
| 81 | 20 2635 | 2675 | 2714 | 2754 | 2793 | 2833 | 2872 | 2911 | 2950 | 2989 | 39 |
| 82 | 3028 | 3067 | 3105 | 3144 | 3182 | 3221 | 3259 | 3298 | 3336 | 3374 | 38 |
| 83 | 3412 | 3450 | 3487 | 3525 | 3563 | 3601 | 3638 | 3676 | 3713 | 3750 | 38 |
| 84 | 3787 | 3824 | 3861 | 3898 | 3935 | 3972 | 4008 | 4045 | 4081 | 4117 | 37 |
| 85 | 4153 | 4190 | 4226 | 4262 | 4298 | 4334 | 4369 | 4405 | 4440 | 4476 | 36 |
| 86 | 20 4511 | 4546 | 4581 | 4617 | 4652 | 4687 | 4722 | 4757 | 4792 | 4827 | 35 |
| 87 | 4861 | 4896 | 4930 | 4965 | 4999 | 5033 | 5067 | 5101 | 5135 | 5169 | 34 |
| 88 | 5203 | 5237 | 5270 | 5304 | 5337 | 5370 | 5404 | 5437 | 5470 | 5503 | 33 |

## XXXIII. $\mathfrak{T}_b$ for Ogival-headed Projectiles ($\Pi = 1{\cdot}206$ kil. or $\omega = 527$ grains).

| b | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *m. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 5 | 1074 | 1102 | 1129 | 1156 | 1181 | 1206 | 1230 | 1252 | 1274 | 1296 | 24 |
| 6 | 1316 | 1336 | 1355 | 1374 | 1392 | 1409 | 1426 | 1443 | 1459 | 1474 | 18 |
| 7 | 1489 | 1504 | 1518 | 1532 | 1545 | 1558 | 1571 | 1584 | 1596 | 1608 | 13 |
| 8 | 1619 | 1630 | 1641 | 1652 | 1662 | 1672 | 1682 | 1692 | 1701 | 1711 | 10 |
| 9 | 1720 | 1729 | 1737 | 1746 | 1754 | 1762 | 1770 | 1778 | 1786 | 1793 | 8 |
| 10 | 1800 | 1808 | 1815 | 1822 | 1828 | 1835 | 1842 | 1848 | 1854 | 1860 | 7 |
| 11 | 1 866·6 | 872·7 | 878·5 | 884·1 | 889·6 | 895·1 | 900·5 | 906·0 | 911·4 | 916·5 | 5·5 |
| 12 | 921·7 | 926·6 | 931·4 | 936·3 | 941·1 | 945·7 | 950·3 | 954·9 | 959·4 | 963·8 | 4·7 |
| 13 | 968·1 | 972·4 | 976·7 | 980·8 | 984·8 | 988·8 | 992·8 | 996·7 | *000·5 | *004·3 | 4·0 |
| 14 | 2 008·1 | 011·7 | 015·3 | 018·9 | 022·4 | 025·9 | 029·3 | 032·7 | 036·1 | 039·4 | 3·5 |
| 15 | 042·6 | 045·9 | 049·1 | 052·2 | 055·2 | 058·2 | 061·2 | 064·2 | 067·1 | 070·0 | 3·0 |
| 16 | 2 072·9 | 075·7 | 078·5 | 081·3 | 084·0 | 086·7 | 089·3 | 091·9 | 094·5 | 097·1 | 2·7 |
| 17 | 099·6 | 102·1 | 104·6 | 107·0 | 109·4 | 111·8 | 114·1 | 116·5 | 118·8 | 121·1 | 2·4 |
| 18 | 123·4 | 125·6 | 127·8 | 130·0 | 132·1 | 134·2 | 136·3 | 138·4 | 140·5 | 142·6 | 2·1 |
| 19 | 144·6 | 146·6 | 148·6 | 150·6 | 152·5 | 154·4 | 156·3 | 158·2 | 160·0 | 161·9 | 1·9 |
| 20 | 163·7 | 165·5 | 167·3 | 169·1 | 170·8 | 172·6 | 174·3 | 176·0 | 177·7 | 179·4 | 1·7 |
| 21 | 2 181·0 | 182·6 | 184·2 | 185·8 | 187·4 | 189·0 | 190·6 | 192·2 | 193·7 | 195·2 | 1·6 |
| 22 | 196·7 | 198·2 | 199·6 | 201·1 | 202·5 | 204·0 | 205·4 | 206·8 | 208·2 | 209·6 | 1·4 |
| 23 | 211·0 | 212·4 | 213·8 | 215·2 | 216·5 | 217·8 | 219·1 | 220·4 | 221·7 | 223·0 | 1·3 |
| 24 | 224·3 | 225·6 | 226·8 | 228·1 | 229·3 | 230·5 | 231·7 | 232·9 | 234·1 | 235·3 | 1·2 |
| 25 | 236·4 | 237·6 | 238·7 | 239·8 | 240·9 | 242·0 | 243·1 | 244·2 | 245·2 | 246·3 | 1·1 |
| 26 | 22 47·33 | 48·36 | 49·38 | 50·39 | 51·38 | 52·36 | 53·34 | 54·30 | 55·25 | 56·20 | ·99 |
| 27 | 57·13 | 58·04 | 58·95 | 59·85 | 60·74 | 61·62 | 62·49 | 63·36 | 64·21 | 65 05 | ·88 |
| 28 | 65·88 | 66·71 | 67·53 | 68·33 | 69·13 | 69·92 | 70·70 | 71·47 | 72·24 | 73·00 | ·79 |
| 29 | 73·76 | 74·50 | 75·24 | 75·97 | 76·69 | 77·40 | 78·11 | 78·81 | 79·50 | 80·18 | ·71 |
| 30 | 80·85 | 81·52 | 82·19 | 82·84 | 83·49 | 84·14 | 84·78 | 85·41 | 86·03 | 86·65 | ·64 |
| 31 | 22 87·26 | 87·86 | 88·45 | 89·04 | 89·61 | 90·16 | 90·69 | 91·22 | 91·73 | 92·22 | ·55 |
| 32 | 92·71 | 93·18 | 93·63 | 94·07 | 94·50 | 94·90 | 95·29 | 95·67 | 96·04 | 96·42 | ·41 |
| 33 | 96·79 | 97·15 | 97·50 | 97·85 | 98·19 | 98·52 | 98·85 | 99·18 | 99·50 | 99·81 | ·34 |
| 34 | 23 00·12 | 00·43 | 00·74 | 01·05 | 01·35 | 01·65 | 01·95 | 02 24 | 02·53 | 02·82 | ·30 |
| 35 | 03·11 | 03·39 | 03·67 | 03·95 | 04·23 | 04·51 | 04·78 | 05·05 | 05·31 | 05·58 | ·27 |
| 36 | 23 05·84 | 06·10 | 06·36 | 06·62 | 06·87 | 07·13 | 07·38 | 07·63 | 07·87 | 08·12 | ·25 |
| 37 | 08·36 | 08·60 | 08·84 | 09·08 | 09·31 | 09·54 | 09·77 | 10·00 | 10·23 | 10·46 | ·23 |
| 38 | 10·68 | 10·90 | 11·12 | 11·34 | 11·56 | 11·78 | 11·99 | 12·20 | 12·41 | 12·62 | ·22 |
| 39 | 12·83 | 13·03 | 13·23 | 13·43 | 13·63 | 13·83 | 14·03 | 14·23 | 14·42 | 14·62 | ·20 |
| 40 | 14·81 | 15·00 | 15·19 | 15·38 | 15·57 | 15·75 | 15·94 | 16·12 | 16·30 | 16·49 | ·19 |
| 41 | 23 16·67 | 16·85 | 17·03 | 17·21 | 17·38 | 17·56 | 17·73 | 17·91 | 18·08 | 18·25 | ·18 |
| 42 | 18·42 | 18·59 | 18·76 | 18·93 | 19·09 | 19·26 | 19·42 | 19·59 | 19·75 | 19·92 | ·17 |
| 43 | 20·08 | 20·25 | 20·41 | 20·57 | 20·72 | 20·87 | 21·02 | 21·18 | 21·33 | 21·49 | ·16 |
| 44 | 21·64 | 21·80 | 21·95 | 22·10 | 22·25 | 22·40 | 22·55 | 22·70 | 22·85 | 23·00 | ·15 |
| 45 | 23·14 | 23·29 | 23·43 | 23·58 | 23·72 | 23·87 | 24·01 | 24·16 | 24·30 | 24·44 | ·14 |

## XXXIII. $\mathfrak{T}_b$ for Ogival-headed Projectiles (*continued*).

| b | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *m. s.* | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | Seconds | + |
| 46 | 23 24·58 | 24·72 | 24·86 | 25·00 | 25·14 | 25·28 | 25·42 | 25·56 | 25·69 | 25·83 | ·14 |
| 47 | 25·96 | 26·10 | 26·23 | 26·37 | 26·50 | 26·64 | 26·77 | 26·90 | 27·03 | 27·17 | ·13 |
| 48 | 27·30 | 27·43 | 27·56 | 27·69 | 27·82 | 27·95 | 28·07 | 28·20 | 28·33 | 28·46 | ·13 |
| 49 | 28·58 | 28·71 | 28·84 | 28·97 | 29·09 | 29·22 | 29·34 | 29·46 | 29·58 | 29·71 | ·13 |
| 50 | 29·83 | 29·95 | 30·07 | 30·19 | 30·31 | 30·43 | 30·55 | 30·67 | 30·79 | 30·91 | ·12 |
| 51 | 23 31·03 | 31·15 | 31·27 | 31·39 | 31·50 | 31·62 | 31·74 | 31·86 | 31·97 | 32·09 | ·12 |
| 52 | 32·20 | 32·31 | 32·42 | 32·54 | 32·65 | 32·77 | 32·88 | 32·99 | 33·10 | 33·21 | ·11 |
| 53 | 33·32 | 33·44 | 33·55 | 33·66 | 33·77 | 33·88 | 33·99 | 34·10 | 34·20 | 34·31 | ·11 |
| 54 | 34·42 | 34·53 | 34·63 | 34·74 | 34·85 | 34·95 | 35·06 | 35·16 | 35·27 | 35·37 | ·11 |
| 55 | 35·48 | 35·58 | 35·69 | 35·79 | 35·89 | 36·00 | 36·10 | 36·20 | 36·30 | 36·41 | ·10 |
| 56 | 233 6·508 | 6·609 | 6·709 | 6·809 | 6·909 | 7·009 | 7·109 | 7·208 | 7·307 | 7·405 | ·100 |
| 57 | 7·503 | 7·601 | 7·698 | 7·796 | 7·893 | 7·990 | 8·086 | 8·182 | 8·277 | 8·373 | ·097 |
| 58 | 8·468 | 8·564 | 8·659 | 8·754 | 8·849 | 8·943 | 9·036 | 9·129 | 9·222 | 9·315 | ·094 |
| 59 | 9·408 | 9·501 | 9·593 | 9·685 | 9·776 | 9·867 | 9·958 | *0·048 | *0·138 | *0·228 | ·091 |
| 60 | 234 0·317 | 0·407 | 0·496 | 0·585 | 0·673 | 0·761 | 0·849 | 0·937 | 1·024 | 1·110 | ·088 |
| 61 | 234 1·195 | 1·282 | 1·368 | 1·454 | 1·539 | 1·624 | 1·708 | 1·792 | 1·876 | 1·959 | ·085 |
| 62 | 2·042 | 2·125 | 2·207 | 2·289 | 2·371 | 2·453 | 2·534 | 2·615 | 2·695 | 2·775 | ·081 |
| 63 | 2·855 | 2·935 | 3·014 | 3·093 | 3·171 | 3·249 | 3·327 | 3·405 | 3·482 | 3·559 | ·078 |
| 64 | 3·635 | 3·711 | 3·786 | 3·862 | 3·937 | 4·012 | 4·086 | 4·161 | 4·235 | 4·309 | ·075 |
| 65 | 4·382 | 4·455 | 4·528 | 4·601 | 4·673 | 4·745 | 4·816 | 4·887 | 4·958 | 5·028 | ·072 |
| 66 | 234 5·098 | 5·168 | 5·238 | 5·308 | 5·377 | 5·446 | 5·515 | 5·584 | 5·652 | 5·720 | ·069 |
| 67 | 5·788 | 5·856 | 5·923 | 5·990 | 6·057 | 6·124 | 6·190 | 6·256 | 6·322 | 6·388 | ·067 |
| 68 | 6·454 | 6·519 | 6·584 | 6·649 | 6·713 | 6·778 | 6·842 | 6·906 | 6·970 | 7·034 | ·065 |
| 69 | 7·098 | 7·162 | 7·225 | 7·289 | 7·352 | 7·416 | 7·479 | 7·542 | 7·605 | 7·668 | ·063 |
| 70 | 7·730 | 7·793 | 7·855 | 7·917 | 7·979 | 8·041 | 8·103 | 8·165 | 8·227 | 8·289 | ·062 |
| 71 | 234 8·351 | 8·413 | 8·474 | 8·536 | 8·598 | 8·660 | 8·721 | 8·782 | 8·843 | 8·904 | ·062 |
| 72 | 8·965 | 9·026 | 9·086 | 9·147 | 9·207 | 9·268 | 9·328 | 9·389 | 9·449 | 9·510 | ·061 |
| 73 | 9·570 | 9·630 | 9·690 | 9·750 | 9·810 | 9·870 | 9·929 | 9·989 | *0·048 | *0·108 | ·060 |
| 74 | 235 0·167 | 0·227 | 0·286 | 0·345 | 0·404 | 0·463 | 0·522 | 0·581 | 0·639 | 0·698 | ·059 |
| 75 | 0·756 | 0·815 | 0·873 | 0·932 | 0·990 | 1·048 | 1·106 | 1·164 | 1·222 | 1·280 | ·058 |
| 76 | 235 1·337 | 1·394 | 1·451 | 1·508 | 1·565 | 1·622 | 1·679 | 1·736 | 1·792 | 1·849 | ·057 |
| 77 | 1·905 | 1·961 | 2·016 | 2·072 | 2·127 | 2·182 | 2·237 | 2·292 | 2·347 | 2·402 | ·055 |
| 78 | 2·456 | 2·510 | 2·564 | 2·618 | 2·672 | 2·726 | 2·779 | 2·832 | 2·885 | 2·938 | ·054 |
| 79 | 2·991 | 3·044 | 3·096 | 3·148 | 3·200 | 3·252 | 3·304 | 3·356 | 3·408 | 3·459 | ·052 |
| 80 | 3·510 | 3·561 | 3·612 | 3·662 | 3·712 | 3·762 | 3·812 | 3·862 | 3·911 | 3·960 | ·050 |
| 81 | 235 4·009 | 4·058 | 4·107 | 4·156 | 4·204 | 4·253 | 4·301 | 4·349 | 4·397 | 4·444 | ·048 |
| 82 | 4·491 | 4·539 | 4·586 | 4·633 | 4·680 | 4·727 | 4·773 | 4·820 | 4·866 | 4·912 | ·047 |
| 83 | 4·958 | 5·004 | 5·049 | 5·094 | 5·139 | 5·184 | 5·229 | 5·274 | 5·318 | 5·363 | ·045 |
| 84 | 5·407 | 5·451 | 5·495 | 5·539 | 5·582 | 5·625 | 5·668 | 5·711 | 5·754 | 5·797 | ·043 |
| 85 | 5·839 | 5·882 | 5·924 | 5·966 | 6·008 | 6·050 | 6·092 | 6·134 | 6·176 | 6·218 | ·042 |
| 86 | 235 6·259 | 6·300 | 6·341 | 6·382 | 6·422 | 6·463 | 6·503 | 6·544 | 6·584 | 6·624 | ·041 |
| 87 | 6·663 | 6·703 | 6·742 | 6·782 | 6·821 | 6·860 | 6·899 | 6·938 | 6·976 | 7·015 | ·039 |
| 88 | 7·053 | 7·091 | 7·129 | 7·167 | 7·205 | 7·243 | 7·281 | 7·319 | 7·356 | 7·393 | ·038 |

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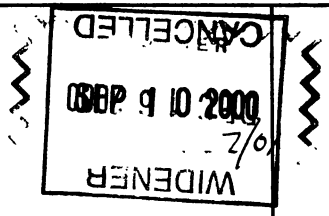


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